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SPEED VARIATION OF SHUNT MOTORS.

The suitability of the shunt motor for driving machinery at varying speeds has frequently been set forth. There are, however, several opinions as to the best method of securing the desired changes in speed. As the speed of the motor is determined by three factors—the number of armature conductors, the strength of the magnetic field and the voltage applied to the armature—the speed may be varied by changing any one, or any combination of the three.

Methods of Changing Speed.

The simplest change to make is that of the field strength, the change being effected by varying the field current; though it may also be brought about by a change in the reluctance of the air-gap. But it has been held by many that this method, while ideal in theory, is of doubtful value in practice because of the difficulty of avoiding sparking at all speeds and also because this method calls for a motor several times as large as would be necessary if the machine were to be operated only at the highest speed, some declaring that for a change of speed of two to one, the increase in the motor should be as four to one. These arguments have resulted in the bringing out of several systems in which one of the other factors is changed, either alone or in combination. We have thus the multiple voltage systems and the double commutator motor. In the first, the voltage applied to the armature is varied; in the second, the armature has a double winding, making possible a change in the number of armature conductors connected in series. These systems if used alone change the speed of the motor in steps and, moreover, are more or less complicated. While the voltage at the armature may be varied continuously by means of a series resistance, this method is too wasteful to be considered except for temporary work, or for but slight changes in speed. On the other hand, the method of shunt control is efficient as well as continuous and simple if a sufficiently wide range can be covered.

Wide Speed Range with Shunt Control.

In an article published in the London *Electrician* for December 4, Mr. H. M. Hobart contends that it is possible to design a motor which while not being too expensive will give a speed range of five to one. To secure this attention must be paid to the following points: the highest speed of the motor must be somewhat less than the customary speed for a motor of equal output; the design should have as high a ratio of length of armature to diameter as is consistent with sparkless commutation, and the highest practical commutator subdivision must be adopted.

Standard Brush Position.

Mr. Hobart makes a strong plea for adopting as standard for motors a fixed brush position at the geometrical neutral plane, as this is not only desirable for constant speed motors, but is more important for variable speed machines and essential for reversible motors. The author also believes that the speeds called standard to-day are too high and that a better machine can be built if a lower speed is decided upon, and a design calling for a long armature of small diameter is selected. He believes that the greater number of manufacturers are spending too much on their low-speed motors and too little on their high-speed motors, because they do not recognize the importance of these points in design and are wont to lay too much importance on obtaining as high peripheral speed as possible. In other words, Mr. Hobart believes that with a proper attention paid to the points mentioned, the shunt motor will give a wide range of speed and will show no unfavorable condition, giving an ideal drive.

ELECTRICITY IN ILLUMINATION AND ITS RELATION TO THE FIRE HAZARD.

Of the numerous standards for expressing the advancement of enlightened humanity, such as conditions of highways, methods of taxation, property rights of women, commercial credits, or even the gallows, as cited in this respect by Armenius Vambery in his travels through Central Asia, there is none which appears to stand the test so well as that of artificial illumination.

The Universal Adoption of Artificial Illumination.

There is a sound economic reason why this should be the fact, because artificial illumination lengthens the productive day, until now, like the fiat of Joshua, the sun does stand still, so that almost every kind of occupation can be performed with equal facility whether the sun be in the zenith or below the nadir.

Modern illumination differs from the early methods of lighting, from the lucernæ of ancient Rome to the tallow dips of our grandfathers, in that they merely revealed the presence of objects, largely by their shadows, like a certain type of Japanese pictures, and served to render the darkness visible, while the flood of artificial light under modern methods reveals minute details.

Under such conditions, the hours after sundown were available only to primitive occupations and duties which did not require close observation, but the later developments of illumination permitted the exercise of occupations hitherto feasible only between sunrise and sunset.

The Rewards for Artificial Light.

Such has been the demand for better illumination, that those who have supplied that demand have been rewarded with the smiles of fortune. New Bedford whalers became independent at forty.

The refining of petroleum into illuminating oil has established fortunes beyond the dreams of avarice.

Gasworks have been proverbially mints in spite of the rivalry of kerosene, and in many cases the impediment of wasteful chemical processes of gas generation.

Electricity an Essential in the Production of Artificial Light.

It was into this fully occupied field that electricity intruded and immediately established itself as an essential addition, and, furthermore, developed the application of other illuminants to an extent far beyond the work of their own promoters.

When New York was first invaded by electricity by the tower at Madison Square, whose coronet of arc lights cast shadows of the gas flames of the street lights upon the pavement below, there was consternation among the gas interests.

A conference of gas magnates was hastily assembled for the purpose of evolving some methods of meeting the new rival, and the panic was for the moment almost thrown into a rout by the statement of one of their number who was the largest owner of gas stocks in the country, that the advances of electric lighting must be met with masterful inactivity.

When pressed for reasons he said that electric lighting undoubtedly had its limitations, but the very fact that at Madison Square and at other points there was stronger artificial light would cause consumers of gas to require more light, and therefore become better customers.

Within a week from the time when electric lights were started in Madison Square two of the large hotels in the neighborhood ordered their gas regulators disconnected, and throughout New York there was a great demand for gas tips which would give larger flames.

At that time began the introduction of more powerful kerosene burners.

The Influence of Artificial Light in Augmented Production.

The influence of electric illumination as a factor of prosperity in augmenting the amount of production can never be integrated from the numerous contributory causes, but the manufacturer knows with that commercial keeness developed by competition that he must have electricity, or the "seconds" made under artificial light, which cost as much as "standards" for both raw material and labor, will be out of proportion greater than those of his competitors.

The orthochromatic properties of electric light have stimulated decoration, especially in theatres where artificial light is always used.

The absence of necessary provision for discharging the products of combustion, as in a gas flame, has enabled the redesigning of lighting fixtures, leaving the artist free to place the source of light in direct relations to the space to be illuminated.

The absence of vitiation of air has contributed to sanitary conditions; if it be correct that one four-foot gas burner impairs the air as much as the respiration of ten people, this improvement is indeed a notable one.

The Safeguards in Electrical Illumination.

Illumination without flame has permitted the use of artificial light in many processes of manufacture, where the dangers of exposed flame rendered it formerly out of the question.

It is related that when a committee of the insurance association called at the Edison company's office on Fifth avenue many years ago, they were shown the startling experiment of immersing a lighted incandescent lamp into oil; and it is maintained that the experience of years has justified the broad purpose of that experiment to indicate the safety of electricity in artificial illumination.

It is not merely a comparison of results of hazard with that of other methods of illumination, for it is applied in places where any other method of illumination is unfeasible.

Its units have multiplied on itself in number and the scope of its applications is so broad as to tax credulity as to the extent. In all these places the full range of hazards known to insurance are met, and it is proverbial that most large fires destroy the evidence of their origin; but it is the universal belief of those most intimately connected with the installation and operation of electric lighting apparatus that electricity is the safest means of illumination, and that its disparagement in this respect can not be sustained by facts.

The Attitude of Insurance Underwriters.

The value of the property devoted to electric illumination

is so extensive that the insurance reaches to a large amount, and it is a frequent complaint that the rates on such property are excessive in comparison with the fire losses sustained on such properties.

The rejoinder may be made that if the rates are inequitable why is insurance carried?

Under existing commercial methods, credits are based upon property, and a company is frequently obliged to use its credit in the event of large purchases of supplies, and a fund available for the restoration of burned property would require the use of a large amount invested outside of the purposes of the business; in the case of a bonded indebtedness it is customary to protect the bondholders by assignment of the insurance to their benefit.

Therefore insurance is necessary in the maintenance of a property of few units, but it is only equitable that the insurance companies which receive the utmost from the state should in turn write the insurance upon a tariff based closely upon the results of experiences on fire losses.

ACTION OF LIGHT ON GERM DISEASES.

An interesting, though perhaps, at present unwarranted, extension of the wave theory of radiation was suggested recently by a gentleman who has devoted much time to the study and propagation of electrical waves. In speaking of the use of Rœntgen rays and other invisible radiations for the treatment of disease, he pointed out that, although these diseases are believed to be brought about by germs, they can not be detected by the microscope. Such germs must be exceedingly small, and it would therefore seem fair to presume that in size they are of the same order as the wave-length of the ray which affects them. Moreover, such germs may be supposed to be enclosed in a sheath or skin of more or less insulating nature.

Action of Light Rays on Minute Organisms.

Under such conditions, could not the effect of the ray be explained by the assumption that the germs respond to a certain wave-length, and have electric currents set up in them, which, if the tuning were accurate, would be sufficient to cause their destruction? Working on this hypothesis, the investigator should endeavor to determine just what particular wave-length is most effective with each disease, and by the use of proper screens, eliminate all others, as in this way the maximum effect on the disease would be secured, with the minimum effect on the other tissues. Possibly the physician of the future will have a complete set of screens, each designed to let through a certain wave-length, and used in treating certain disease; and it would only be a logical step from this to classify such diseases by the length of wave to which the germ is in tune. This classification would not only be scientific, but most helpful to the unfortunate victim, to be able to designate his affliction by a letter or a numeral rather than the long unpronounceable non-memorizable names now in use.

SINGLE-PHASE ELECTRIC TRACTION.

On another page of this issue will be found a description of the electropneumatic traction system developed by Mr. Bion J. Arnold, of Chicago, Ill., the well-known consulting engineer, and president of the American Institute of Electrical Engineers. It will be seen that a single-phase motor is employed, the compressed-air machinery being used as an auxiliary for starting and for carrying the car over such portions of the track as are not equipped with the electrical supply system.

Mr. Arnold has been a consistent advocate of the use of alternating-current motors for traction purposes for some years past, and he claims the distinction of being the first to run a car by means of a single-phase motor. It is greatly to be regretted that the deplorable accident on the eighteenth of December last, which destroyed his motor, made impossible the public test which was planned for January 1.

The difficulty in the use of alternating currents for traction purposes has been the poor starting qualities of polyphase induction motors and the number of conductors required; the inability of single-phase induction motors to start without auxiliary devices, and the undesirably low power-factor of these types. While in the latter respect synchronous motors are better, they are even poorer starters than the induction motors. As regards the alternating-current commutating motors, it is only recently that such machines have been thought at all feasible. Mr. Arnold's work has consisted in adding to a single-phase alternating-current motor an auxiliary device which will supply its deficiencies and improve the condition of operation, the auxiliary device in this case being compressed air. Thus, two old rivals were to be harnessed together, and the advantages of each secured to supply the deficiencies of the other.

THE NEW YEAR NUMBER OF THE ELECTRICAL REVIEW.

The next issue of the ELECTRICAL REVIEW will be the New Year Number, containing the annual review of progress in electrical science and application during the year just closed. As has been our custom, we will present in this issue a number of reviews of the various branches of applied electricity, prepared by specialists in each subject. It is the aim to make each of these as complete as possible, so that the workers in any field may find there a record of the progress in other fields, which, owing to the great development in their own subjects, it has been impossible for them to follow.

It is also well, at least once a year, to take stock, as it were, of our progress, not only in order that some definite idea may be gained of the profit and loss, but that a clear conception may be formed of the trend of matters, with a view to outlining future policies. This phase of the question will not be neglected in our reviews.

A HAPPY NEW YEAR.

To our host of friends scattered throughout the entire world, we extend the compliments of the season and wish them a happy and prosperous New Year. The year just closed has been noteworthy for the general prosperity and the substantial advance made in all lines of electrical manufacture and development; and indications point to a continuance of these conditions. We trust that, as the year advances, this forecast will be verified, and that all engaged in electrical enterprises will reap a full share of a rich harvest.

THE ACCURATE MEASUREMENT OF SMALL RESISTANCES WITH THE KELVIN DOUBLE BRIDGE.[1]

BY W. JAEGER, S. LINDECK AND H. DIESSELHORST.

The construction of small resistances as described by K. Fenssuer[2] in 1890 has become of great importance, especially in relation to the exact measurement of heavy currents. About 400 resistances between 0.01 and 0.00002 ohm have been verified at the Reichsanstalt in the last seven years, and most of these are correct to within a few hundredths of one per cent.

The accuracy obtainable in the comparison of such small resistances is widely underrated; as a matter of fact it approaches the accuracy obtained in the measurement of higher resistances. Since no detailed information on this subject has yet been published, it is reported here in detail.

In the Reichsanstalt the Kelvin double bridge has been used from the beginning for resistances under one ohm. The resistances whose measurement is here described comprise principally standards from 0.1 ohm to 0.0001 ohm, whose values have been used in division 2 for a number of years in testing resistances sent in. Once a year these standards are determined in terms of the one ohm standards of division 2, and the latter at the same time accurately compared with the standards of division 1. It was desired to supplement these determinations by other independent determinations made at the same time by other observers, and thereby obtain a check on the agreement obtainable in the measurement of small resistances.

For this purpose W. Jaeger and H. Diesselhorst made a careful measurement of the resistances referred to, in December, 1901, in division 1, and S. Lindeck, in February, 1902, in division 2. The first set gave opportunity to test the availability of a Deprez-d'Arsonval galvanometer (furnished by Siemens & Halske) for this purpose. The two series of measurements differ, as explained later, in the method of applying the correction term which appears in the formula for the Kelvin double bridge. This paper is accordingly divided into the following sections:

1. Small resistances and the Kelvin double bridge in general.

2. Measurements of December, 1901, in division 1.

3. Measurements of February, 1902, in division 2.

4. Comparison of two sets with each other and with previous measurements.

5. Appendix. 1. Sensibility of the Kelvin double bridge. 2. Applicability of the Deprez-d'Arsonval galvanometer to the measurement of small resistances.

SMALL RESISTANCES AND THE KELVIN DOUBLE BRIDGE IN GENERAL.

The diagram of the Kelvin double bridge is given in Fig. 1[1]. Here A and

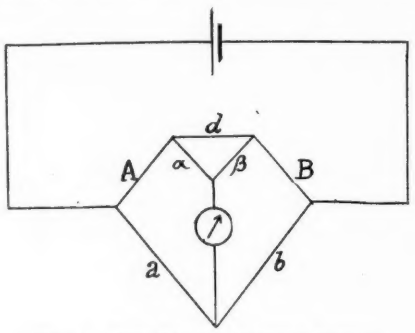


FIG. 1.—THE KELVIN DOUBLE BRIDGE.

B designate the small resistances to be compared, a and b the ratio coils, d the connecting resistance between A and B, α and β the auxiliary ratio coils. The current in the galvanometer is zero if

$$\frac{A}{B} - \frac{a}{b} + \frac{d}{B} \cdot \frac{\beta}{\alpha + \beta + d} \left(\frac{\alpha}{\beta} - \frac{a}{b} \right) = 0 \qquad (1).$$

If the auxiliary ratio coils α and β be in exactly the same proportion as the main ratio coils a and b, the equation reduces

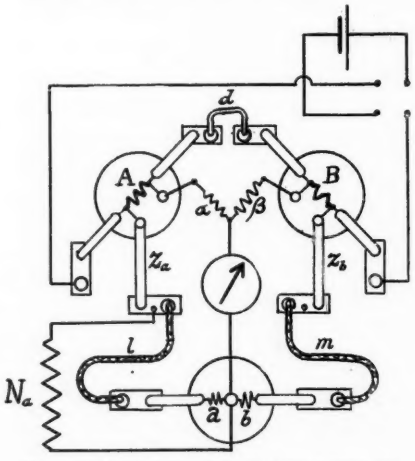


FIG. 2.—ARRANGEMENT OF APPARATUS IN MAKING MEASUREMENTS.

to the form corresponding to the ordinary Wheatstone bridge

$$A : B :: a : b$$

If α and β are not exactly in this proportion, a correction term enters, whose importance is greater the smaller the resistances to be compared, and the larger d becomes. d can not be reduced indefinitely, as there must always be some resistance in the connection between A and B; for the resistance of the standards is not taken between the ends of the current terminals, but is defined as the value between the potential terminals.

Sir William Thomson was the first to make use of such potential terminals (*l. c.*). Defining the resistance of a body as he did by the junction of two potential terminals with two current terminals, von Helmholtz[1] has proven that the resistance is not changed by using the potential terminals for current leads and using the current terminals for potential. Apparatus may sometimes be arranged more conveniently by making use of this theorem. The interchange of current lead and potential terminal on one side only is, however, in general not admissible.

With resistances not too small (down to 0.01 ohm) it is not hard to make the correction term negligible by avoiding unnecessary resistance in the connection d and choosing for α and β resistances nominally in the ratio $a : b$. In accurate measurements of resistances of 0.001 ohm and smaller, however, allowance for this correction must be made and its value accurately determined. There are several ways of doing this, and as a check, different methods were used in the two sets of measurements.

II.—MEASUREMENTS IN DIVISION 1.

In order to apply the correction, it is necessary to know the ratio $\alpha : \beta$. This was determined in division 1 by an auxiliary measurement which followed directly after the main observation. By breaking the connection d, reference to Fig. 1 shows that we have left an ordinary Wheatstone bridge in which the ratio $A + \alpha : B + \beta$ is given by the ratio $a : b$.

To make use of this, it is convenient to write formula (1), by a slight transformation in the form

$$\frac{A}{B} - \frac{a}{b} + \frac{d}{B} \cdot \frac{B + \beta}{\alpha + \beta} \left(\frac{A + \alpha}{B + \beta} - \frac{a}{b} \right) = 0$$

In the correction term B may be neglected in comparison with β, and since approximately $A : B :: \alpha : \beta$ we may also write

$$\frac{A}{B} = \frac{a}{b} \left(1 - \frac{d}{A + B} \omega \right) \qquad (2)$$

where

$$\omega = \frac{A + \alpha}{B + \beta} \cdot \frac{b}{a} - 1 \qquad (3)$$

ω is determined by the auxiliary measurement above mentioned. In addition, d and the other connecting resistances must be determined. This is done by direct deflection of the galvanometer.

The arrangement of apparatus is shown in Figs. 2 and 3. Fig. 2 shows the comparison of resistances nominally equal. In this case the ratio coils (100 ohms each) are arranged so that they may be interchanged without disturbing the shunt N_a (or N_b as the case may be). The connections are made by the flexible cords l and m which terminate in the mercury

[1] Communication from the *Physics-Technical Reichsanstalt*. Abridged translation from *Zeitschrift für Instrumentenkunde*, by Morton Githens Lloyd, Ph.D.

[2] *Zeit. f. Instrumentenkunde*, x, p. 425.

[1] W. Thomson, *Phil. Mag.*, xxiv, p. 149 (1862).

[1] H. von Helmholtz, *Pogg. Ann.*, lxxxix, p. 353 (1853).

cups, and by crossing these the ratio coils are interchanged, and a second observation made. By taking the mean of the two observations, the effect of any inequality in the ratio coils or the cord connections is eliminated. Fig. 3 shows the comparison of unequal resistances. Here there is no interchange, and the connecting cords become unnecessary, but the ratio $a : b$ must be exactly known from other measurements. The potential terminals of the small resistances, A and B, under comparison, are indicated.

All of the resistances are made of manganin, and are used in baths of petroleum, whose temperature is observed. The arrangement is sometimes simpler and more convenient if use be made of the theorem of Helmholtz, above mentioned; with resistances of 0.01 ohm and greater, experience has shown that the mutual substitution or interchange of potential terminals and current terminals may be made on one side only without affecting the measurement. The measurement may be divided into three parts, which will be considered separately, *viz.*, (1) connecting re-

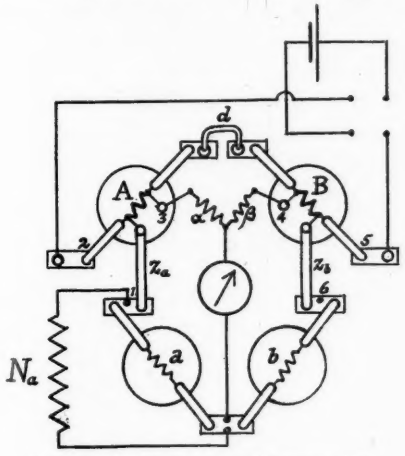


FIG. 3.—COMPARISON OF UNEQUAL RESISTANCES.

sistances and leads; (2) the ratio $a : b$ (the principal measurement); (3) the value of the correction ω (the auxiliary measurement).

1. Connecting Resistances and Leads—In this regard, stress must first of all be laid on the requirement that in making the necessary changes in the bridge between the individual observations, the values of the connecting resistances must not be altered. Attention must be paid particularly to the places where binding-posts are used, as at the potential terminals of the small resistances. If an accuracy of one part in a million be sought, care is necessary even with a resistance of ten ohms, and great caution is required with one ohm. On this account, the connection between A and B is made by a thick piece of copper (d in Figs. 2 and 3) which rests in two mercury cups. It adds but little to the resistance, and in changing the bridge from the main to the auxiliary observation, it can be taken out without touching any of the other apparatus.

(To be continued.)

INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—V.

NOTES ON PROGRESS IN EUROPE AND AMERICA.

BY JOHN B. C. KERSHAW.

Ozone and Its Utilization for Water Purification.

The success of Messrs. Siemens & Halske in obtaining funds for the erection of two ozone water-purification plants in Germany at Schierstein and Paderborn, respectively, has revived interest in this use of ozonized air; and in many quarters it seems to be thought that this is an absolutely new application of electrical energy. The following notes, however, will show that Messrs. Siemens & Halske have not been the only pioneers in this application of electricity. The Andreoli form of ozonizer was experimented with by the inventor in London in the years 1898-99; and in the latter year figures were published showing the results obtained with this ozonizer, when the ozonized air was applied to the purification of Thames water. Still earlier, or in 1897, the Tindel & van der Steen ozonizer was being tried upon a fairly large scale for the purification of river Seine water in Paris, and a concession was obtained from the municipal council of that city in connection with these trials.

In 1898, M. M. Marmier & Abraham, the inventors of yet another form of ozonizer, commenced to experiment in a similar manner with the town water supply at Lille, as this city was then suffering from a typhoid fever epidemic; and very full reports of the chemical and bacteriological results obtained in these trials appeared in most of the foreign technical journals in 1899 and 1900.

The Vosmaer-Lebret ozonizer is also now being experimented with at Schiedam in Holland for the same purpose—water purification—and Professor van't Hoff has stated that this system of purification will probably be applied in the near future, to portions of the town water supply of Rotterdam. Experiments of a similar kind have also been carried on in 1901 and 1902 at Lea Bridge, near London, in connection with the East London Water Company's supply.

These facts and dates prove that many inventors and experimenters have attempted to solve the problem of water purification by means of ozonized air. The fact that water can be sterilized in this manner is well established, and it is necessary to emphasize the fact that the problem to be solved is not a scientific one, but an economic one. Most of the trials and experiments referred to above have failed, because the costs of treatment were excessive; and if Messrs. Siemens & Halske have succeeded at Schierstein and Paderborn in rendering the ozone treatment a commercial success, it will be by careful attention to the £ s. d. side of the problem.

Tin.

The writer gave some details in the ELECTRICAL REVIEW of March 14, 1903, concerning the electrolytic methods of recovering tin from tin scrap. The following are notes bearing on this subject which have come into his hands since the earlier paragraph was written and published.

The Bremer-Metallwerke at Hemelingen, Germany, has started a works for the treatment of metal residues and ores (presumably by electrolytic and metallurgical methods combined). The plant for the recovery of tin from tin scrap will form an important branch of the new works. In Austria the Chem-Fabrick Elektron, of Pfaffstätten, and the firm of Schefftel, of Floridsdorf, near Vienna, recover tin from waste tin scrap. In these Austrian works the electrolyte used is a ten to twenty per cent solution of caustic soda at sixty to seventy degrees centigrade. One dynamo generating 800 amperes at eight volts suffices to strip 100 to 125 quires of tinned sheets per week. In England, Bachelor & Company, of Birmingham, and two other firms are stated to be engaged in the industry, and the competition for raw material, especially from Germany, is stated to be very keen. This confirms the fact published in the earlier note, to the effect that Germany is drawing some portion of her supplies for the seven factories of this description operating there from the United Kingdom. A new company has also quite recently been registered in London for the purchase of a factory carrying on the same business. The new company is called the British Electric Separating Company and has a capital of $30,000. The works taken over is situated at Swansea in South Wales, which would appear to be a good centre for this industry. In time not only every country, but every large city will doubtless possess a tin-stripping factory; for the value of the recovered metal is fairly high, and a small plant would not require excessive capital to erect or carry on. As before pointed out, the collection of the waste material is the most troublesome and expensive part of the business; but in large cities, with a

well-organized dust and scavenging department of municipal service, the collection of all tin cans from the refuse should prove a source of revenue to the public funds.

The writer has not heard of any tin-stripping factories being at work in New York, or other city of the United States; but doubtless one or more such factories are in operation, and details will be received by him with pleasure from those interested in this branch of electrometallurgy.

Peat Fuel.

In a note published in the ELECTRICAL REVIEW of February 28, 1903, the writer gave some details of the Jebsen process for producing charcoal from peat—a process that is in operation at Stangfihorden in Norway. The Jebsen process is based upon the removal of the water from the crude peat by mechanical pressure, and by heating in hot air tunnels; the partially dried product from these two operations is then carbonized in retorts of special construction, heated by internal electric resistance coils. The Jebsen process has received much notice in the technical press, and according to a recent report the resulting peat fuel sells at the high rate of $5 per ton. The apparent success of this process in Norway has had the usual effect of stimulating attention to the subject in other countries; and the question of utilizing portions of the immense peat deposits of Ireland in a similar manner is now attracting much attention. An electrical process for treating peat, exhibited recently in operation upon an experimental scale at Messrs. Johnson & Phillips Works, at Charlton, in Kent, has in consequence received unusual consideration at the hands of the editors of the London technical journals; and the space devoted to this process would appear to have been in about inverse ratio to its merits.

The Carmichel process differs from the Jebsen process in the use of the electric current, not for heating purposes, but to break up the water (remaining in the peat after partial drying) into its constituent atoms; and it is claimed for the process that this electrolytic action of the current not only removes the remaining water, but also helps to disintegrate the fibres of the peat and thus prepare the way for the final briquette-making operations. The preliminary drying in the Carmichel process is effected by centrifugal machines; the half-dried mass is then rendered conducting by the incorporation of certain chemicals, and electrolytic action is brought into play by the insertion of electrodes at various points in the mass.

No definite information was given at the demonstration referred to, of the kilowatt-hours required to dry one ton of peat in this way, and in the absence of this information it is of course impossible to arrive at any reliable opinion upon the future of the process. The writer is, however, inclined to class the Carmichel process with other processes foredoomed to failure. The use of the electric current to remove water from material which contains roughly between twenty and thirty per cent of it, even after passing through centrifugal machines, would certainly not prove remunerative, even with the kilowatt at the low charge of $5 per annum.

Assuming that a potential difference of five volts is sufficient to give the required current through the mass of peat, a simple calculation shows that 8,760 kilowatt-hours would only decompose 588 kilogrammes of water. One ton of partially dried peat contains on the average twenty-five per cent of water (raw peat contains from fifty to seventy per cent water), and therefore at least 4,400 kilowatt-hours would have to be expended to remove this water from the final product, which would then weigh only 0.75 ton. The cost of electrical energy for the drying process would consequently be over $3, and would nearly equal the sale value of the peat fuel when finally obtained. It is therefore extremely unlikely that the Carmichel process will solve the peat fuel problem.

An Electric Thermostat.

Mr. Horace Darwin recently exhibited at a meeting of the Physical Society an electric thermostat. The thermostat shown at the meeting was made for Lord Berkeley, and is similar to one made for the spectrograph of the twenty-four-inch refractor of the Royal Observatory, Cape of Good Hope. The vessel, the temperature of which is to be maintained constant, is surrounded by oil contained in a bath. In the oil are placed two heating coils, through which electric currents pass. By automatically controlling these currents the temperature of the oil, and consequently of the inner vessel, is kept very nearly constant. The control is effected by means of a Wheatstone bridge in the outer oil bath. This bridge has two opposite arms of copper and two of manganin, so that it is only balanced at some definite temperature. Its deviations from balance affect the position of a long horizontal boom attached to the suspended coil of a galvanometer. The position of the boom determines the greater or less descent of a "hit or miss" arm which is periodically raised by a rotating cam, and can only fall to its lowest position when the galvanometer boom is to one side and allows it to pass. This position of the boom corresponds to a fall of temperature of the controlling bridge. Thus the position of the "hit or miss" arm at its lowest position depends on the temperature, and it is the variation of this position which regulates the amount of current passing through the heating coils. When the "hit or miss" arm is at its highest position the galvanometer boom is absolutely free to move to its position of equilibrium. We may call the two coils the intermittent and the premanent heating coils. At every rotation of the cam the "hit or miss" arm is lowered, and if it passes the galvanometer boom a key is closed and a current passes through the intermittent heating coil. Thus the frequency of the intermittent current depends on the temperature of the oil bath. The duration of the time that the key is closed also varies, it may be long or very short. Every time the key is closed a movement takes place which increases the duration of the next closure of the key. The arrangement of the mechanism is such that when the temperature is steady the "hit or miss" arm will pass the galvanometer boom as many times as it is stopped by it in a given time. The current passing through the permanent heating coil is also automatically regulated; if there is not enough heat passing into the coil this current is gradually increased. This is done by cutting out resistance coils which are in series with the permanent heating coils. The cam which moves the "hit or miss" arm is driven by a worm gear and any suitable motor, and the oil is kept thoroughly stirred by a fan.—*London Mechanical Engineer.*

The Sibley Journal of Mechanical Engineering.

The *Sibley Journal of Mechanical Engineering,* published at Cornell University, Ithaca, N. Y., for November, 1903, is an elaborate memorial testimonial to Dr. Robert Henry Thurston. A well-executed half-tone photograph makes a becoming frontispiece for this memorial. The literary contents include a biographical notice by William Kent; contributions from prominent engineers; a testimonial entitled "Our Friend," by John H. Barr; an article entitled "Dr. Thurston's Work in Sibley College," by H. J. Ryan and R. C. Carpenter; an article entitled "The Literary Work of Dr. Thurston," by H. Diederichs; and a partial list of papers by Dr. Thurston.

Photographing Alternating-Current Wave-Forms with the New Duddell Oscillograph.

By Frank C. Perkins.

ONE of the most important of electrical scientific instruments recently developed is the Duddell oscillograph, and it is filling an important place in the equipment of electrical lighting, power and manufacturing plants, as well as the leading technical colleges in this country and abroad. It is particularly valuable at the present time on account of the great extension of the use of single-phase and polyphase alternating currents in power transmission and railway work, and a knowledge of the shape of the alternating-current wave-forms is of great importance.

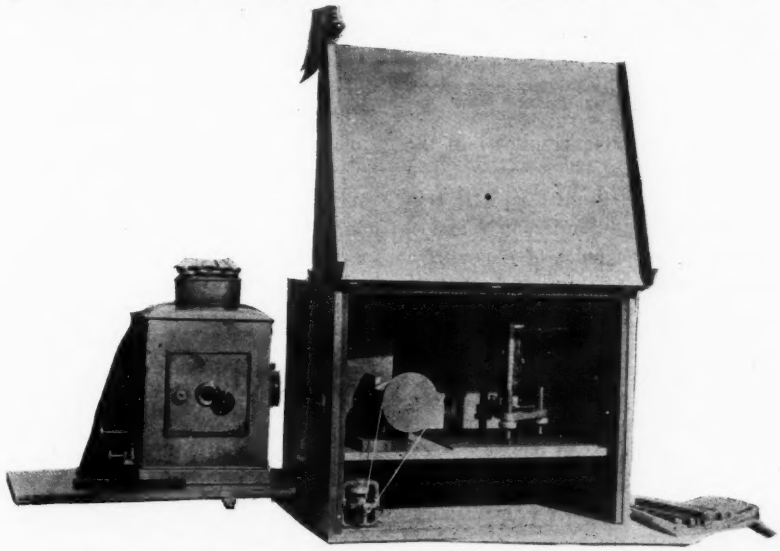


FIG. 1.—DUDDELL OSCILLOGRAPH USING FALLING PHOTOGRAPHIC PLATE.

The accompanying illustration, Fig. 1, shows one of the latest Duddell oscillographs, using a falling photographic plate. A photographic plate, three and one-quarter inches by six and three-quarter inches, falls by gravity down a slide or wooden tube so that the spots of light from the mirrors of the oscillograph on the stand within, which are vibrating horizontally, trace out on the plate the required curves. With this apparatus the plate is caught in a bag below and a rotating mirror is provided which allows the wave-form to be examined visually for making the exposure.

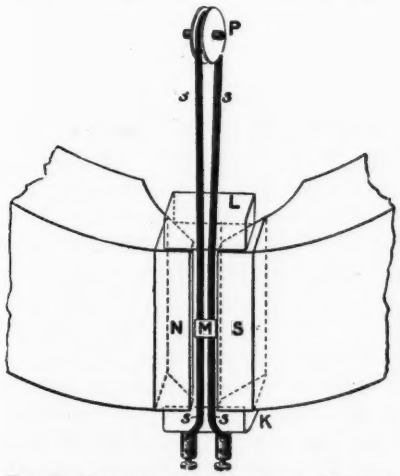


FIG. 3.—OSCILLOGRAPH VIBRATING SYSTEM.

With alternating currents of fifty or sixty cycles per second, the height of the slide is such that the mean speed of the plate when exposure is being made is 400 centimetres per second. Bags and clips are used for introducing the plates into and removing them from the vertical slide, several bags being provided for the purpose, the slide being introduced at the top, resting on a catch ready to be released at any moment desired. The oscillograph is noted in Fig. 1 in the case through which the vertical slide passes, and a small motor is also seen rotating the mirror in order that visual observations may be made previous to exposure. As soon as the operator notes that the curves in the rotating mirror are those desired or are of special interest to be recorded, he releases the catch and this allows the plate to fall and a permanent record is made on the negative which is absolutely free from personal errors. An arc lamp is provided in the hood with hand-feed mechanism as a source of light to produce the best photographic records. This apparatus is used in combination with several forms of oscillographs, as the high-frequency double instrument and the single and double permanent magnet instruments, the latter being used for studying high-tension circuits of from 10,000 volts to 15,000 volts.

In the accompanying illustration, Fig. 2, may be seen the arrangement of the Duddell oscillograph as constructed at Cambridge, England, by the Cambridge Scientific Instrument Company, Limited, with a cinematograph camera attached which produces continuous curves on a moving film as shown in Fig. 8. This is a record taken on a moving picture film, showing the potential difference and current curves of an alternator and indicating the effect of switching on and off a high-tension feeder, a portion of the film

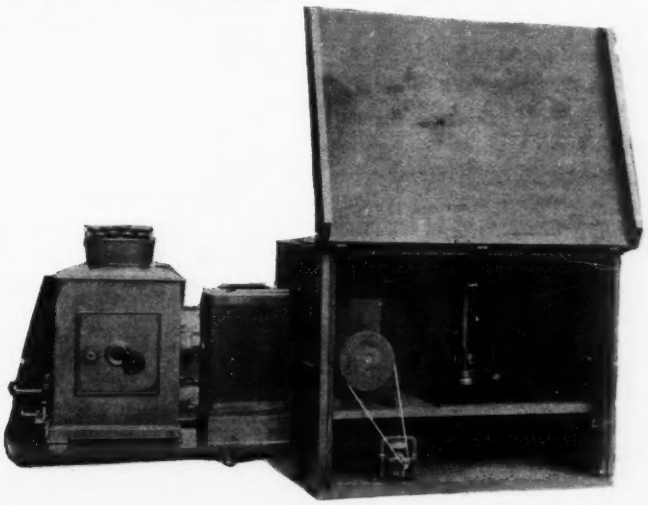


FIG. 2.—DUDDELL OSCILLOGRAPH USING MOVING-PICTURE FILM CAMERA.

being removed from the centre. As will be seen in illustration, Fig. 2, the moving picture film camera is placed in such a position as to take the place of the falling plate. The diagram, Fig. 5 shows

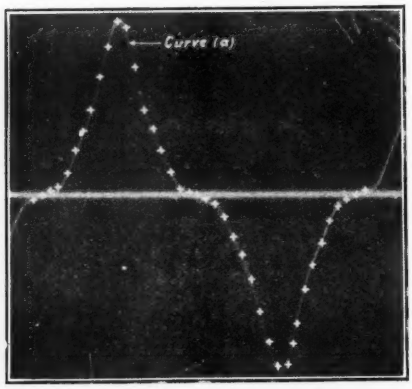


FIG. 4.—OSCILLOGRAPH RECORD OF POTENTIAL DIFFERENCE CURVE OF INDUCTOR ALTERNATOR, FREQUENCY 97 PERIODS PER SECOND, SHOWING COMPARISON WITH JOUBERT POINTS.

the optical system employed in order to make the curves visible and obtain a photographic record, for the oscillograph mirrors are very small, measuring only one millimetre by 0.3 millimetre. The arc A is the source of light, C represents the condensing lenses, C′ another condenser and I a negative lense, forming a parallel beam nozzle. A slit S is provided, measuring fifteen millimetres long and one millimetre wide, and M represents the oscillograph mirror, while *c* is a cylindrical lens which converges the image of the slit into a small spot at P. The image of the source of light A is focused on the mirror M; P and M being at the conjugate foci of the cylindrical lens. In some instances a single lens is employed in place of the condensers C and C′ and I.

An instrument has been devised for projection work and in this case the diaphragm S is circular and about five millimetres in diameter and the cylindrical lens *c* is omitted from the arrangement. A photographic drum instrument has also been designed, and when this is used a reflecting prism is used between the slit S and the lens I. The curve, Fig. 4 is a record of an inductor alternator of a frequency of ninety-seven periods per second. The small crosses on this potential difference curve show the comparison of the oscillograph record with Joubert points, the latter falling almost exactly upon the curve throughout its entire length.

The cinematographic film camera combined with the oscillograph is particularly valuable for taking long records, which are of great value during investigations covering a considerable period of time, as when motors are running up to speed, when alternators are being placed in parallel and when noting the surges which may occur in switching on and off cables with the apparatus shown in Fig. 2. Long films may be obtained of the type shown in Fig. 9, of 150 or 200 feet if desired, the moving picture film being driven at a uniform speed past the exposure aperture by means of a small one-sixth-horse-power motor. An automatic brake and starting lever are found of value to avoid waste of film, the latter being quickly stopped and started when desired in this manner.

The vibrating system employed in the Duddell oscillograph is indicated in a simple manner in diagram Fig. 3, M representing the vibrating mirror, N and S the north and south poles of a powerful magnet, which is a permanent magnet in some instruments and an electromagnet in others. The two strips of phosphor-bronze *s s* are two parallel conductors which pass over the pulley P, a light spring

FIG. 5.—DIAGRAM OF ARC LAMP, CONDENSERS, SLIT MIRROR AND POINT OF LIGHT, SHOWING OPTICAL SYSTEM.

balance being attached to the latter, the periodicity of the oscillograph being varied by varying the tension. These strips are held in position at the top by a bridge piece L and are clamped on the block K, at the bottom, and each strip passes through a separate gap in the magnetic circuit, the clearance being only 0.038 millimetres. A viscous oil is used in these gaps and the surface tension of this oil holds a small lens in position, the latter at the same time keeping the oil in place, the movements of the strips being damped by the oil.

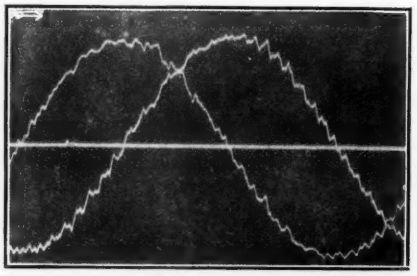


FIG. 6.—FALLING PLATE OSCILLOGRAPH RECORD OF POTENTIAL DIFFERENCE CURVES OF A TWO-PHASE ROTARY CONVERTER, INDICATING IRREGULARITIES DUE TO SPARKING.

It is stated that the natural period of vibration of the loop and mirror, which is turned about a vertical axis, is 0.0001 of a second in the high-frequency instruments and the damping effect of the oil is said to be so great that accurate results are obtained with frequencies of over 300 periods per second. The instantaneous value of the current is proportional to the lineal displacement of the spot of light reflected by the mirror, and the spot of light oscillates to and fro as the current is varied, tracing a straight line.

The photographic plate is moved in a direction at right angles to the direction of movement of the spot of light and in this way an image of the wave-form is produced. By vibrating or rotating a second mirror so as to impart to the beam of light a uniform motion proportional to time in a plane at right angles to the plane of vibration of the beam due to the current, the spot of light will trace out on a stationary screen the potential difference or current curve by interposing this second mirror in the path of the beam of light. Such a rotating mirror is indicated in Fig. 1, as well as in Fig. 2, driven by a small electric motor.

The double high-frequency oscillograph has a magnetic field produced by an electromagnet having eight coils, series-connected, in pairs, the terminals being arranged for various connections so that it may be excited by a current of 25, 50 or 100 volts pressure, or by placing a 110-volt eight-candle-power lamp in series with the field coils it may be excited from a 200-volt circuit. As

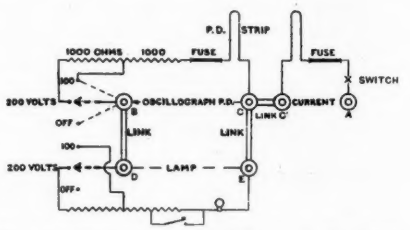


FIG. 7.—CONNECTIONS OF DOUBLE PORTABLE OSCILLOGRAPH.

the magnetic circuit is saturated there is no need of adjusting the exciting current, a change of one per cent sensibility being produced only by a change of four per cent or more from the correct value of the exciting current. This instrument may be used as a voltmeter by placing a resistance in series with the strips, and by shunting the strips it may be used as an ammeter. On account of the high sensibility of this oscillograph and its very short periodic time, from one eight-thousandth to one ten-thousandth of a second, it is very well suited for research work and is largely utilized in technical schools.

Both single and double permanent magnet oscillographs have been designed

at Cambridge, the latter having the advantage that two wave forms may be recorded simultaneously, although the sensibility is somewhat less than that of the former. Both of these instruments have the advantage of requiring no direct current for magnetization and are always ready for use, and the damping is correct at the ordinary temperature of the room, no thermometer being necessary, as there is little or no change in the prepared damping oil over the whole range from ten degrees centigrade to twenty degrees centigrade. The periodic time for both the single and the double permanent magnet oscillographs is one five-thousandth of a second, which is twice as long as that of the high-frequency instrument, but still short enough to give accurate results at all of the ordinary frequencies.

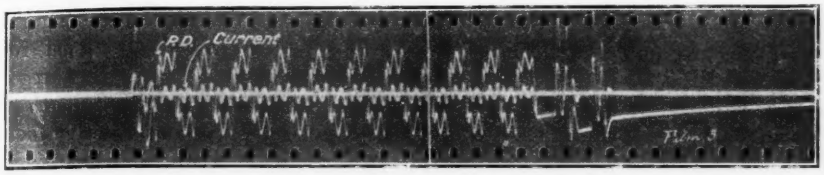


FIG. 8.—OSCILLOGRAPH RECORDS USING MOVING-PICTURE FILM CAMERA, NOTED IN FIG. 2, SHOWING CURRENT CURVES OF ALTERNATOR, INDICATING EFFECT OF SWITCHING ON AND OFF A HIGH-TENSION FEEDER.

Fig. 7 shows the connections of the double portable oscillograph, BC being

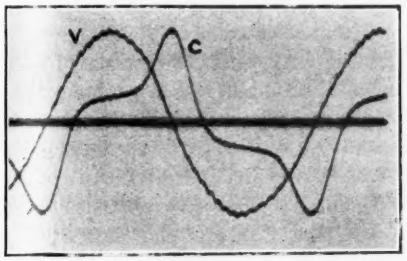


FIG. 9.—ALTERNATING-CURRENT AND POTENTIAL DIFFERENCE CURVES OF A ROTARY CONVERTER, SHOWING RIPPLES DUE TO ARMATURE TEETH.

the terminals to which the voltage wires are to be connected; A and C being connected to the terminals of the shunt for current wave-forms. This instrument has a rotating mirror, the necessary resistances and an incandescent lamp, the beam of light from the lamp being focused on the oscillograph mirror, from which it is reflected on a screen, forming a bright spot, which vibrates horizontally. The mirror is rotated by hand and the movement of the spot is observed in the mirror through eyeholes, a rubber eye shade preventing extraneous light from entering the instrument when in use.

The oscillograph is extremely valuable for carefully studying the wave-forms of alternating-current apparatus, and the information is of importance to those in charge of this class of apparatus. The wave-form has a great effect upon the efficiency of alternating-current motors and transformers, and often an economy may be effected by the choice of a suitable wave-form. It has also been stated that by having a flat topped electromotive force curve instead of a peaked curve, the light per watt of an alternating arc or luminous efficiency has been found to be between forty and fifty per cent higher. Mr. Field's paper before the Glasgow section of the Institution of Electrical Engineers shows the seriousness of some resonance effects which are very striking. The breakdown of high-tension and extra high-tension cables, it is said, is often due to definitely avoidable resonance conditions, which may be carefully studied by means of the photographic wave-forms.

Fig. 9 is a record of the direct-current potential difference curve of rotary converter shown below and above the potential difference curve between one slip ring and one commutator brush indicating the ripples due to the armature teeth.

The oscillograph is in reality a moving coil galvanometer and the variations of wave-forms can be observed and recorded as they occur, while irregular, non-periodic changes in potential difference or current can be recorded with equal ease, whether the circuit be a direct or an alternating-current one. The indices are spots of light sufficiently small and intense for either visual observation or for photography. The possibility of taking two or more wave-forms simultaneously is also of great value, as it is extremely interesting to note the wave-forms of the current in a given circuit, and at the same time to be able to note the difference of potential between any two points on the circuit. There is no question but that this instrument will be very extensively used in the near future with the great development of alternating-current installations.

Cavitation in Lubrication.

At a recent meeting of the British Physical Society, a paper was read by Mr. S. Skinner, on "Cavitation in Lubrication." The experiments described arose from an observation made when determining the refractive index by means of Newton rings. These rings are obtained when a liquid is run into the space between the lenses. If, now, where the liquid has been introduced, the upper lens be rolled on the lower, the observer sees a crescent-shaped space following the central dark spot. This crescent is very bright, provided the illumination be sufficiently oblique. It is a vacuous or vapor-filled space, for, when the motion of rolling ceases, the liquid flows into the space and completely fills it. The effects are more pronounced the more viscous the liquid. The cavities which are formed must be produced either by splitting the liquid itself, or by tearing it from the glass surface.

Some experiments were made to imitate an actual case of a fully lubricated axle rolling under a bearing. For this purpose a thick disc, with its edge worked to a spherical surface of curvature equal to the radius of the disc, mounted on an axle, was arranged so that the lower part of the disc dipped into the oil bath, while a flat piece of glass rested on the upper edge of the disc. As the disc rotated, oil was carried around so that the point of contact of the disc and plate was maintained copiously lubricated. On rotation, it was seen that a cavity was formed on the side where the edge of the disc was moving away from the plate. The size of the cavity depended on the rate of rotation. In ball bearings completely immersed in oil, experiments showed that there must be a small cavity near the point of nearest approach of each ball to its neighbors, and also to the surface on which it is running. As the friction of the bearing is the viscous friction of the oil, it follows that the friction must be considerably reduced by the formation of these cavities, which are filled with relatively non-viscous vapor. The high lubricating property of oils owes its origin, not only to their superior viscousity, but also possibly to the facility with which cavities may be formed in them.

Fog Prevention by Electricity.

Sir Oliver Lodge recently received a letter from Mr. J. W. Bradley, city engineer of Westminster, London, England, asking whether it would not be possible to devise an arrangement applicable to street arc lamps, so as to permit a discharge of electricity at a large number of points into the air, and thus prevent or disperse fogs. In reply, Sir Oliver thinks the suggestion practical, but states there would be much difficulty in securing adequate insulation. If this could be guaranteed, the matter would be comparatively easy. The potential should be about 100,000 volts, and as the quantity is small, very little power would be required, provided, of course, leakage could be avoided. In the Liverpool experiments, Sir Oliver used voltages over 100,000, and could draw sparks four inches long; but a smaller voltage would do if there were walls or other earthed surfaces in the neighborhood. Although the fogs are due to incomplete combustion, reform in this matter will take some time, and, meanwhile, fogs are a nuisance. Fogs at sea and in harbors come in a different category, but it is quite appropriate to attempt to deal with them. There is, however, no more difficulty in dealing with one than the other, and, in fact, the thicker the fog, the more easily it is dealt with, for only adequate arrangements are necessary for the genuine supply of electricity into the air.

STANDARDIZATION OF CONSTRUCTION.[1]

BY F. C. POLK.

I take it that the subject, "Standardization of Construction," may be interpreted to mean not so much as to what shall constitute standard construction, but as to whether construction should be standardized and how such standardization can be brought about and made effective.

As to the first proposition, "What should constitute standard construction?" we will not attempt to answer, for the reason that I believe no one person is capable of, nor should presume to tell this convention of what standard construction shall consist. Not that we do not have among us capable engineers and construction superintendents, but that all of us, in our experiences and operations, have been confined to more or less local fields with comparatively short periods of observation under various conditions. For these reasons we are incompetent to propose methods which shall be the standard and guide of us all, and be applied upon all occasions, circumstances and conditions under which a company may be operating.

The conditions under which the numerous telephone companies have been organized and are now operating are so varied that I feel safe in asserting that it is an impossibility for any one to formulate a set of specifications or plan of construction which would be applicable in all cases and in accordance with which all companies could practically and successfully operate. Some one says it is not necessary that these specifications and plans be made up in detail, but only cover certain general facts or principles which would apply in all cases and which, if conformed to, would be practical and result in universal benefit.

All right; we will start with an article which enters into and forms the foundation of construction of all modern plants in the majority of cities having a population of 35,000 and upward—underground conduit.

There is the single duct, multiple duct, clay conduit, iron pipe, cement line pipe, cement conduit, paper conduit, creosote wood, etc., all of various sizes and shapes, laid in a variety of ways, all in use, and all giving satisfaction to the parties using them. Which shall be standard, and how shall it be laid? Here are the manufacturers, each telling us his is the best, cheapest, most durable. We can not use them all and at the same time have an effective standard. I am sure if we adopted one of the above as a standard and proceeded to utilize it as such, it would not remain the cheapest very long.

Go to the next article, which enters into the construction of all plants, whether large or small, modern or antiquated—poles. Shall they be cedar or chestnut? White cedar or red cedar? Northern cedar or western cedar? Cypress or tamarack? Shall they have four-inch tops or five? Six or seven? Eight or nine? Or even greater? What height shall they be, twenty feet or sixty? I can conceive of circumstances and conditions under which any of the above would be applicable. Which, then, shall be made standard and adhered to upon all occasions?

Now, as regards wire. There are iron and copper, both of varying gauges. Neither can be made the standard at present, for there are conditions under which either may be judiciously and successfully used, both with various gauges within certain limits.

There is cable. Of what sized wire shall it consist? What insulation? What capacity? What character of sheath? We can not specify to which of the many qualifications it shall conform and say it must be universally used. I remember visiting a town a short time ago of less than 10,000 inhabitants and the manager taking pride in telling me that he had an underground cable system, cable up to conference specifications, and all that. This system extended about four or five hundred feet from the office, cable of 19 gauge wire, 0.08 capacity, 500-megohm insulation. The specifications were good if the cable had the qualities enumerated, and should be required in certain cases, but in the particular instance cited the manufacturer simply used these qualifications for an excuse for charging an exorbitant price for his goods. Cable of 22 gauge wire, 0.12 capacity, would have served just as well and operated as satisfactorily, and cost less money.

We could go on through the list of construction material, such as cross-arms, cable-boxes, terminals, protectors, hardware, etc., and meet with the same situation and reach similar conclusions to those outlined. In view of the above facts it is certainly clear that it would not be safe or wise to say, at the present time at least, as to what shall constitute standard construction.

Going to the next proposition, as to whether construction should be standardized? Certainly, if it is practical and possible to do so. Under present conditions I do not believe that it is either possible or practical to have a standard of construction in the independent telephone field. The primary reason for this belief lies in the fact of there being such a large number of separate and distinct organizations constructing and operating each with its individual and personal ideas which it insists upon following, regardless of results for good or evil thereby inflicted upon its neighbor; also the fact of the large number of manufacturers and supply houses from whom it is possible to purchase material and equipment, precludes the possibility of an early standardization. All of these manufacturers produce certain articles which are good and which any operating company could wisely purchase. As a large number of these manufacturers produce articles of the same character and for the same purpose, but of a different type, the possibility of standardizing them is prevented, for the present at least. Also, owing to the recent developing of the business, independent telephony is in its evolutionary stage. New ideas and inventions are being brought forth, we might say almost daily, which prove to be improvements over previous materials used. We should not, therefore, retard the progress of these improvements for the sake of keeping to a standard. Whenever we reach a time when this evolution seems to have reached its zenith, if it is possible for this condition ever to arise, this will be the opportune moment for standardization.

Although it appears that the time is not ripe for our complete success, the question arises, "What can be done to make our progress more rapid, that we may reach our aims as quickly as possible?" At the present time, there is no doubt large sums of money are wasted on account of the lack of uniformity. We see companies being constructed and operated under conditions as favorable for one as the other, yet one is more successful than the other. Usually the causes which bring better results for one than for the other can be traced to its method and character of construction. In fact, failures due to faulty construction have been narrowly averted. It therefore seems that although we may not be able to bring about uniformity we should begin to formulate plans that would enable and prevent our weaker brethren from coming so near to failure and bankruptcy.

Another feature which makes it very important for us to have some general methods, is on account of the necessity

[1] Abstract of a paper read before the Interstate Independent Telephone Association, Chicago, December 9, 1908.

of enlisting new capital in the field. A promoter obtains a franchise and completes all the necessary preliminaries for beginning the construction of a plant. The conditions are all good, and if the proposition is properly managed there is no doubt of the venture proving successful. The promoter goes before the capitalist with his prospectus. The capitalist is very favorably impressed, but before taking final action he calls upon an engineer to make a technical report. This engineer possibly may have had large experience, but in a limited territory under certain conditions. The conditions in the prospective new field may be extremely favorable, but entirely different from those with which he is familiar, and would call for entirely different modes of construction from those with which he is familiar. The result is he applies his methods to the new field and makes a very bad showing. The capitalist turns down the proposition. This is a state of affairs which is wholly wrong, and unfortunately very often happens.

It seems to me that if we had some national organization board, composed of experienced and practical telephone engineers and construction superintendents, made up from representatives from all parts of the country, familiar with all the conditions and operating features in their various localities, to whom financial men and investors could call upon for advice, results would be more satisfactory. This organization necessarily could not act as a body in all of these cases. However, it could have a standing committee whose personnel would be of its best and most experienced men; these men to be broad and liberal in their views. These parties to keep an eye upon the new propositions coming up in their respective territory. The operating owners and managers in these various sections or territories to be kept advised to this active representative of the national organization in their territory; acquaint them with the fact that they could feel at liberty at any time to call upon this member for advice. This member, in matters to which his attention is called, to only act personally in trivial or unimportant cases. All important matters brought to his attention to be referred to the general committee, and especially all new propositions or large ones calling for new and large investments. In this way the new investor, or new operator, would have a means of knowing where he could turn at any time for advice which would be conscientiously and intelligently furnished. By this means, we would eradicate that most persistent evil standing in the way of successful and rapid progress of independent telephony at the present time—individual personality. The successful issue of a proposition to-day depends too much upon the personality of one individual, who persists in carrying out his own personal ideas regardless of the judgment or advice of associates.

You will probably say, "What if the new promoter does not turn to your committee, and if not, what means has your national board or committee of asserting itself?" It can do this; if the new organizer or promoter called upon outside sources and his prospective investor was incompetently or illy advised, your committee's active representative would immediately bring the matter to the national body's attention, and its national officers could take the matter in hand and take it upon themselves to see that the proper parties were properly advised; and by intelligent and dignified procedure show wherein, from whom and in what manner the ill advice had been given. It would not be long, I believe, until irresponsible and incompetent individuals would lose their prestige; especially in operations of any magnitude. I realize that we are deviating somewhat from the course indicated by our subject. Nevertheless, I believe you will agree with me in the impracticability of accomplishing the results contemplated by our subject, for the present at least, and at the same time agreeing that such results ought to be accomplished. In the meantime, we should be doing something to help bring about the desired end, whenever the opportune moment does arrive. It therefore occurs to me that what we should work for at present is to eliminate personality and strife between ourselves and get the better results which are bound to come from united or combined action.

The question then presents itself, "How shall we get the united action, or results which shall be the best all can furnish?" This I believe can be done something after the plan I have indicated. It possibly will take time, perseverance and considerable labor on some one's part to put the machinery in motion. The officers of our various associations and trade publications could work it out and in time have the machine in successful operation. In order to obtain membership in this national organization, candidates should be very carefully chosen, and entrance to it very closely guarded; only persons of certain minimum number of years of actual experience and practical construction and maintenance of telephone properties should be chosen. Its membership should predominate with practical engineers and superintendents of construction, and not with owners and investors. These men to be chosen on account of their broad experience, broad views and strong personalities, who could be relied upon to give proper advice without fear or favor. The expense of the maintenance of such an organization should not be great and could be maintained by the various telephone associations. I believe the results that would be obtained from the operation of such an organization or bureau would do more toward bringing about standard methods of constructing and operating telephone properties than anything else that could be done at the present stage of development.

The problem which confronts the present construction engineer with most frequency is that he is called upon to construct a plant complete; required to accomplish certain fixed results and put the system upon an operating basis for a specified amount. A large number of items of cost of promotion and organization over which he has no control are incurred, and as these increase the amount allowed for construction is decreased. Then arises the necessity not of following standards and specifications, but of using judgment as to the best that can be accomplished for the means available. Therefore, good construction at the present time is not so much an attribute of following fixed standards and plans as it is the result of individual personality, of being able to meet the local conditions in the best possible manner, using the best materials directly at hand and keeping well within the amount of means available.

Black oxide of manganese, though frequently accompanying veins and deposits of silver ore, is not an indication of the presence of silver in ores containing the manganese. There are many manganese deposits with barely a trace of silver. In some silver mines the manganese is barren, and with its accompanying minerals constitutes the gangue of the vein.

Electric Club Journal.

The Electric Club, Pittsburg, Pa., announces that it will issue an illustrated monthly magazine to be styled the *Electric Club Journal*. The first number will appear February 1, 1904. The immediate purpose is to put into permanent form the engineering papers and technical discussions that form a regular part of the work of the Electric Club. In addition to this the journal will also publish other material of special interest and value to members of the club.

A LETTER FROM B. J. ARNOLD.

ANNOUNCING THE LOSS BY FIRE OF HIS ELECTRO-PNEUMATIC TRACTION SYSTEM.

TO THE EDITOR OF THE ELECTRICAL REVIEW:

As many of your readers know, I have persistently advocated the use of the alternating current directly in the motors for electric railways for several years (see Transactions American Institute of Electrical Engineers' joint meeting with the British Institution of Electrical Engineers, Paris, August 16, 1900; Niagara Falls convention, August 24, 1901; Great Barrington, Mass., June 19, 1902, and New York, September 26, 1902). By referring to the discussions which took place at these meetings and to the technical papers, it will be found that there were few, if any other, advocates in this country of the alternating-current motor for railway work until recently, and that those who supported it abroad advocated the use of three-phase currents until within the last few months. Since my announcement of the principles of my system before the Great Barrington convention, the development of the single-phase alternating-current railway motor has made remarkable strides, both in this country and abroad, and while at that time it had few friends, the development has been such since that it now seems destined to take its place as the leading railway motor, thereby effecting a revolution in electric railway work.

Many of your readers also know that, since announcing the principles of my system before the Great Barrington convention, I have refrained from giving out any further information regarding it, giving as my reasons therefor my desire to test the system thoroughly before making further public statements regarding it, and then to present a full and complete description of it, together with the results of its operation, in the form of a paper before the American Institute of Electrical Engineers. Consistently pursuing that policy, I have conducted my experiments privately and at my own expense, and had so perfected my apparatus that I had hoped to be able to celebrate the incoming of the year 1904 with a public demonstration over twenty miles of railroad, which would conclusively prove that the single-phase electric railway is not only operative, but efficient and less in first cost and operation than any system now in vogue, not meaning to imply thereby that the system which I have developed was necessarily the only system or the best system, for only time can prove the correctness or incorrectness of such statements, but that it was a system which would successfully do the work, and the system which was first developed and first to be put in actual operation upon the first electric railway in the world especially built for single-phase alternating-current motor operation.

That I would have made a demonstration on January 1 was a certainty, to me, until December 18, when I learned by telegraph, while in New York, that the car barns located at Lansing, Mich., of the road upon which I had been experimenting were completely consumed by fire at four o'clock that morning. The fire apparently originated from a stove in the engine house and was communicated so rapidly to the car barns that it destroyed a steam locomotive and two new cars built for my system, as well as my experimental locomotive, thus leaving me unable to make the demonstration as I had planned. In view of the fact, however, that the single-phase electric railway is now receiving so much attention at the hands of engineers and inventors in many parts of the world, and that I believe that the year 1904 will be an epoch-making one, marking the revolution from the direct-current to the alternating-current motor for railway work, as well as the beginning, on a large scale, of the displacement of the steam locomotive on railways by the use of a substantial form of overhead construction rather than the third rail, and from the further fact that I can not get another machine ready in the near future, I have concluded that I will give to the technical press a record of my work up to the present time in order that it, and the system which I have developed, may be properly weighed in comparison with the work and systems of others, leaving the more complete description of the system and the results of its operation to be presented at a later date before the American Institute of Electrical Engineers.

In January, 1900, I rode over the country between Lansing and St. Louis, Mich., a distance of about sixty miles, with a party of gentlemen who desired to build an electric road between these points. This trip resulted in my advising them that the territory was such that I believe the road should be built as economically as possible, and inasmuch as they desired me to assist financially in its construction, I told them I would do so provided I was allowed to construct the road in accordance with certain ideas that I then had in mind, for by such construction the first cost of the road could be kept sufficiently low to warrant its construction, and that if it were built on any one of the systems, standard at that time, the advisability of building it was questionable. The result was that on April 23, 1900, a contract was entered into wherein I undertook to build and equip the road. Engineers were at once placed in the field to locate it, and after the plans were sufficiently completed, the grading, bridging and track work of twenty miles of the road followed, and this much of the road was completed to such an extent that steam trains were put in regular operation over it about November 15, 1901.

For financial reasons the completion of the road was delayed, and in the meantime the development of my system was taking place and the parts being perfected in different offices and shops.

Since it was my intention to experiment with pressure as high as 15,000 volts on the working conductor, all of the line material had to be specially designed, but the work progressed to such an extent that the overhead and line work of twenty miles of road was practically completed and ready for operation about December 15, 1902, and the power installed, so that experiments began in March, 1903. On June 15, 1903, two trips were made, each about three miles long, with my first experimental machine. On the first trip seven persons were carried and on the second trip thirteen persons were aboard.

The result of the experiments with the first motor proved the correctness of the theory and that the machine would work. Inasmuch as it consisted of but one somewhat crude electro-pneumatic motor, it was impracticable to get full and efficient tests of the system, and it was thought best to conduct no further experiments until a complete new double-equipped truck could be perfected. Not being connected with manufacturing establishments, I have been compelled to develop this system under trying circumstances, necessitating the construction of parts in different shops and assembling them at far distant points with crude facilities. This fact, combined with the financial difficulties that have arisen, and the necessity of my having to give the main part of my attention to other matters, have been the causes of the delay in completing the road and the system.

A new double motor equipment, in the form of a locomotive, was finally built and brought to perfect working condition on the evening of December 17, and it was this locomotive, with the necessary instruments for testing purposes, that was destroyed by fire the following morning. Since it is going to be impracticable for me to get a new one constructed for some time, I have thought best to state the facts as outlined above, and give to the technical press a description of the apparatus and the road, reluctantly omitting the records of operation and the tests which I had hoped to have accompany any future statements I made, but which through "the irony of fate" must now be left for the future.

I hand you, herewith, a hastily prepared description of the road and the system, which I trust will be found sufficiently comprehensive to interest your readers.

BION J. ARNOLD.

Chicago, December 26, 1903.

Destruction by Fire of Some of the Property of the American Institute of Electrical Engineers.

The total destruction by fire on December 28 of the printing house of McElroy & Emmet has resulted unfortunately for the American Institute of Electrical Engineers. The last two forms of the November number of the Transactions, which had just been placed on the presses, the forms containing the catalogue of membership and the mailing lists, are lost. All the electrotype plates of vol. xx (a supplementary volume to vol. xix, and containing the papers from September to December, 1902, inclusive, and just about to be run off the press) are lost. The electrotype plates of vol. xxi (containing the papers from January to June, 1903, inclusive, the folios of which were being changed preparatory to printing), are lost. In addition to these losses, there is the further loss in type of all the pages of vol. xxii (containing the papers from July to December, 1903, inclusive).

The Institute office has on file final authors' corrected copies of all these papers, so that nothing has been lost that can not eventually be reproduced. It will, however, involve considerable labor and time to straighten out matters before the papers and discussions can be reset, proofs read, properly paged and electrotyped.

Members of the Institute can appreciate the delay and annoyance caused by a fire of this nature; a fire that affects not only the printed papers and discussions of the Institute, but also the mailing lists. The loss of the mailing lists will no doubt result in some of the Institute mail matter going astray, but it is hoped that under the circumstances the membership will not be exacting.

Means will be adopted immediately to recover from this unfortunate experience, and as soon as matters can be straightened out the Transactions and other printed matter will be issued promptly.

There may be some salvage from the wreck, but the amount of this salvage can not be determined until the insurance adjusters have finished their work.

The Arnold Electro-Pneumatic Railway System, Its Application and Experiments Therewith in Connection with the Lansing, St. Johns & St. Louis Railway.

ROAD-BED AND TRACK.

THE Lansing, St. Johns & St. Louis Railway was originally projected to extend from Lansing, the capital of Michigan, northward through St. Johns, Alma and St. Louis, a distance of about sixty miles, but up to the present time only that portion extending from Lansing to St. Johns, a distance of twenty miles, has been constructed.

This road was built in accordance with steam railroad practice with easy grades and curves, so that steam locomotives could be operated over it until such time as electrical equipment could be put upon it; the idea being to complete the road in such a manner that it could be utilized for both freight and passenger service, and thus secure all the business available from the territory through which it passes.

The road is equipped with sixty-seven-pound T-rail, laid on ties spaced two feet apart between centres, and as alternating high-tension current was to be used but one of these rails was bonded with thirty-eight-inch 4/0 bonds extending entirely around the splice bars.

Since it was impossible to secure rails from the rail manufacturers in time, rails and splice bars were secured from one of the leading steam railways, and this necessitated the adoption of a supported joint and a long bond, as there was not room under the splice bars for concealed bonds.

The road as at present constructed between Lansing and St. Johns has no grades exceeding one per cent and no curves exceeding seven degrees, except in the cities themselves, where the terminals of the road run over the streets and make such curves as ordinary street cars make, the minimum radius being fifty feet. At each city a terminal was planned so that all freight would be diverted to connecting steam roads, thus making it unnecessary for the freight service to pass over the city streets or curves.

At the Lansing end it was necessary to pass over the steam railway tracks of the Pere Marquette Railroad, and this necessitated the construction of a bridge, with pile approaches; the grade as approached from the Lansing end being four per cent for a distance of about seven hundred feet, and after passing over the bridge the descending grade is 2.3 per cent for about five hundred feet. At the St. Johns end there is a grade on the principal street of the town averaging about two per cent for about fifteen hundred feet.

OVERHEAD CONSTRUCTION.

Considerable care was taken in planning a suitable insulator for carrying the trolley wire, and in the construction of the annealed glass insulator used. Wood is used for the pole, cross-arm and brace, and the insulator is supported by means of a short span wire from iron brackets secured to the wooden cross-arm. This construction ensured a high insulation at a low first cost, the entire line having been constructed for but a slightly increased expense over the cost of standard construction, and at the same time so built that in case of failure of the alternating-motor system the standard direct-current motor system could be put into service without changing any parts; even holes for the pins for carrying the extra feeders which would be required were provided.

The working conductor was placed twenty-two feet above the top of the rails in order that train men when standing upon the tops of the freight cars going over the road could not come in contact with the working conductor.

It was planned to operate the entire road from a single 2/0 trolley wire and with one rail bonded as hereinbefore mentioned; this amount of copper being sufficient to operate four forty-ton cars at an average speed of thirty miles per hour with power-house located one and one-half miles from one end of the line, and operating with from six thousand to ten thousand volts on the working conductor.

The power-house is located at one end of the line, owing to the electric company, from which power is purchased by the railroad, having a water power at this point. Current is transmitted to the nearest end of the line over two No. 3 wires. The power is furnished from a 300-kilowatt rotary converter, generating at 380 volts, twenty-five cycles, the energy from which is stepped up to the working pressure of the line. It was the intention, after experimenting a sufficient length of time to determine the best voltage for the working conductor, to have the generators for the permanent plant constructed so as to generate at this determined voltage, and it was for this reason that a temporary rotary converter was first installed to conduct the experiments with.

During the preliminary experimental period upon the apparatus hereinafter described all power was transmitted from the above-mentioned power-house to a point about two miles distant, where were located the car barns in which the preliminary experiments were made.

The conditions under which the first application of the system took place having thus been set forth it may be well, in order to get clearly before the reader the principles on which the system is based, to quote here the statements made by Mr. Arnold before the Great Barrington convention on June 19, 1902, as follows:

The principles underlying the system I advocate, and which I call an electro-pneumatic system, are as follows:

1. A single-phase or multiphase motor, mounted directly upon the car, designed for the average power required by the car, and running continuously at a constant speed and a constant load, and, therefore, at maximum efficiency.

2. Instead of stopping and starting this motor and dissipating the energy through resistances, as is customary with all other systems known to me, I control the speed of the car by retarding or accelerating the parts usually known as the rotor and stator of the motor, by means of compressed air, in such a manner that I save a portion of the energy which is ordinarily dissipated through resistances, and store it to assist in starting the car, helping over grades, for use in switching purposes, and for the operation of the brakes.

3. By this method of control I secure an infinite number of speeds from zero to the maximum speed of the car, which may or may not be at the synchronous speed of the motor, for with the air-controlling mechanism working compressing, the speeds below synchronism are maintained, and by reversing the direction of the air through the controller speeds above, synchronism may be attained for reasonable distances. This feature gives to the alternating-current motor the element absolutely essential for practical railway work, for it permits a car or train to ascend a grade at any speed with the motor working at its maximum efficiency and imparting its full torque to the car. When descending the grade the motor may utilize its full power drawn from the line in compressing air, or it may be used

to compress air with the stored energy of the train, thereby acting as a brake.

4. By virtue of the air-storage feature, each car becomes an independent unit and capable, in case of loss of current from the line, of running a reasonable distance without contact with the working conductor. This feature will enable a car to work on a high-tension trolley wire or active conductor over private right of way, and allow the active conductor to be stopped where the private right of way ceases, and the car to proceed through a city or town on any tracks, whether electrically equipped or not, until it reaches the outskirts of the city or town where it can take up the working conductor again on private right of way. This feature is also valuable in switching work, for each car being independent it can leave the main line track and operate over switches or sidings without complicating the yards with additional overhead or third-rail conductors, thus necessitating through line conductors over main line track or tracks only.

5. Since a single-phase motor can be used the motors can be supplied with current from a single overhead wire or third rail, and with a single-rail return circuit, thus permitting the overhead construction or third-rail construction to conform to the standard of to-day, except that a much higher working voltage can be used, provided the insulation is taken care of. Furthermore, in steam railway work this system, by virtue of its single-phase feature, will only require the use of one of the track rails for the return circuit, thus leaving the other rail for the use of the signal system, which, up to the present time, does not seem to have been satisfactorily solved without the use of one of the track rails.

6. The current will be taken from the working conductor at any voltage up to the limit of the insulation, and in case this voltage is high (I am building my line for 15,000 volts) a static transformer will be carried upon each car and the pressure reduced from the line voltage to the voltage of the motor, which in the case under construction is designed for 200 volts. Where it is unnecessary to utilize so high a line pressure the motor may be designed for the working voltage, and the current fed directly from the working conductor into the motor, thus eliminating the static transformer. When a high-voltage working conductor and static transformer are used, and it is thought advisable to use a working conductor through cities or towns, this working conductor will be supplied with energy through a stationary transformer at each city limit, thus making the working conductor through the cities or towns safe.

7. By virtue of the speed of the motor and its constant load, either when the car is in motion or when it is standing still, and the motor is compressing air, the variable load now customary in electric railway power plants is eliminated, and the power station works at practically a constant load, thereby eliminating a large part of the investment at present requisite in power station and line construction. Furthermore, by virtue of the air-storage feature, each car, in the particular apparatus I have designed, is capable at any time when current is on the working conductor of delivering to the car wheels a much greater torque in proportion to the capacity of the motor than is possible with any electrical system known to-day.

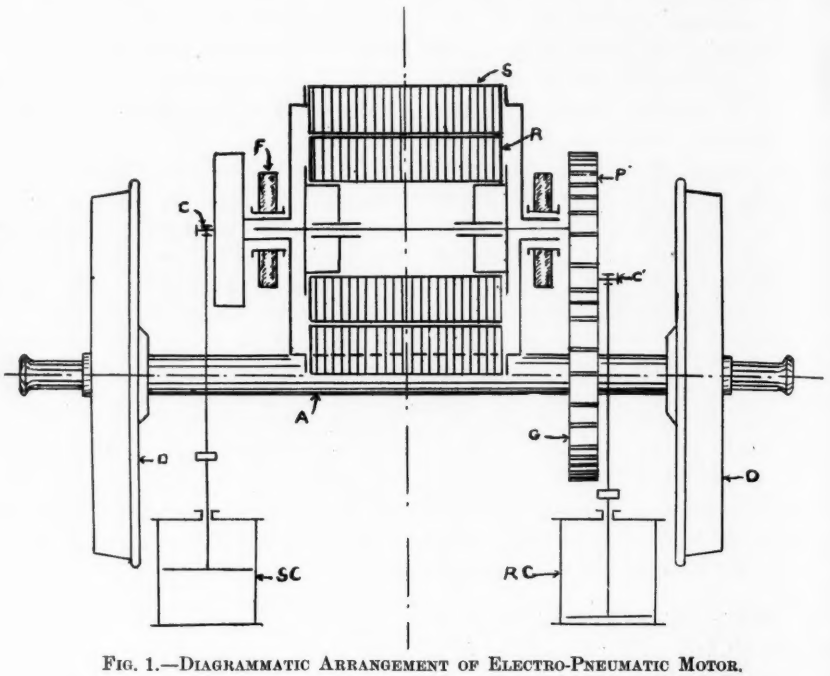


FIG. 1.—DIAGRAMMATIC ARRANGEMENT OF ELECTRO-PNEUMATIC MOTOR.

8. The absorbing and rendering available for useful work in starting, or otherwise, a large percentage of the energy stored in the moving mass, which under the present methods of operation is dissipated at the brake shoes.

9. A large reduction in the first cost of electrically equipping long-distance railroads, thereby making it feasible,

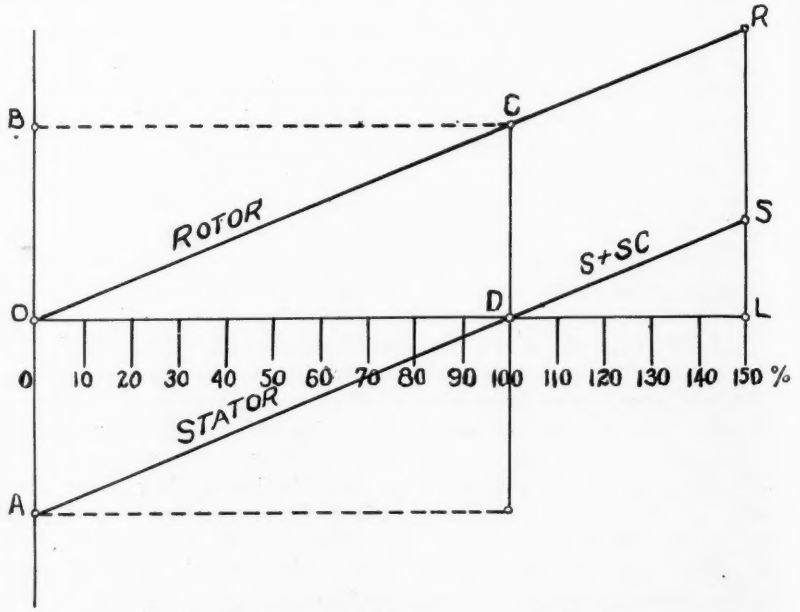


FIG. 2.—DIAGRAMMATIC REPRESENTATION OF OPERATION.

from an engineering and business standpoint, to equip many roads which can not now be shown advisable, thus opening up the steam railway field to the industry in which we are now engaged.

I believe that by the adoption of this system the following results will be accomplished:

1. The entire elimination of the present standard system of rotary converter and substation plant, together with the maintenance thereon, and the cost of the necessary attendants.

2. The absorbing and rendering available for useful work in starting, or otherwise, a large percentage of the energy stored in the moving mass, which under

The following description will explain

more in detail the application of the principles of the system and the mechanism of its working parts:

Fig. 1 represents diagrammatically the working parts of one form of the system: the rotor R of the single-phase induction motor is geared to the axle of the car and by means of crank pin C′ secured in pinion P also drives the compressor cylinder RC, while stator S can freely revolve around the rotor and drive by means of crank pin C the compressor cylinder SC. Both cylinders are piped to air reservoirs located under the car and are also provided with suitable valves manipulated from a single controller on the car platform for making them perform their various functions, thus the entire regulation of the speed and power of the car are controlled by the air cylinders and no other regulating devices are necessary. The cylinder valves are electrically operated, which

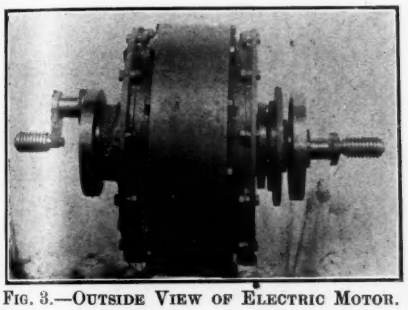


FIG. 3.—OUTSIDE VIEW OF ELECTRIC MOTOR.

makes it possible for each cylinder when driven by the electric motor to compress air into tanks and when operated by compressed air to furnish mechanical energy for moving the car. When, for instance, the cylinder is compressing air the valves work like inlet and outlet poppet valves of a common air pump, while on the other hand if the cylinders are supplied with compressed air each valve is operated electrically by a pilot solenoid connected with the valve seat in such a manner that the energy for moving the valve is supplied by the compressed air, thereby making the valve practically self-actuating. The time of operation of the valves is controlled by a series of collector rings revolving with the engine shaft, and their regular operation is interrupted and varied to suit the requirements by means of the motorman's controller.

When a rotary or turbine type of air engine is used all of the above valves and reciprocating parts are eliminated and the entire controlling mechanism consists of two air valves operated from a single engineer's valve which may be located upon the platform of the car or in the cab of the locomotive, and so arranged that one or more units may be operated from the platform or cab of any unit without the necessity of connecting wires between the units.

This eliminates the necessity of all step-down transformers, resistances or other regulating devices, and confines the current to the motors themselves, and as these are below the car floor the danger

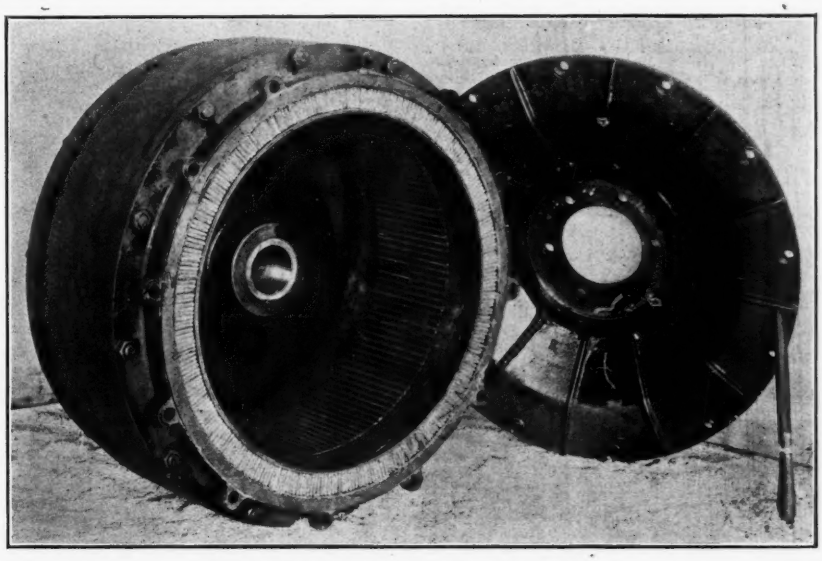


FIG. 4.—INTERIOR VIEW OF ELECTRIC MOTOR.

Since the motor may be of the simplest type of induction motor without a commutator, and the system does not require the manipulation or breaking of the main current, the motor may be designed for any working voltage and be of any type which will maintain a constant speed when provided with a constant load.

from the current is reduced to the minimum.

At the same time the air cylinders, in addition to performing all the functions of speed control, give to the machine the independent unit element, and the ability to store the kinetic energy of the train in stopping and utilize it in starting. On

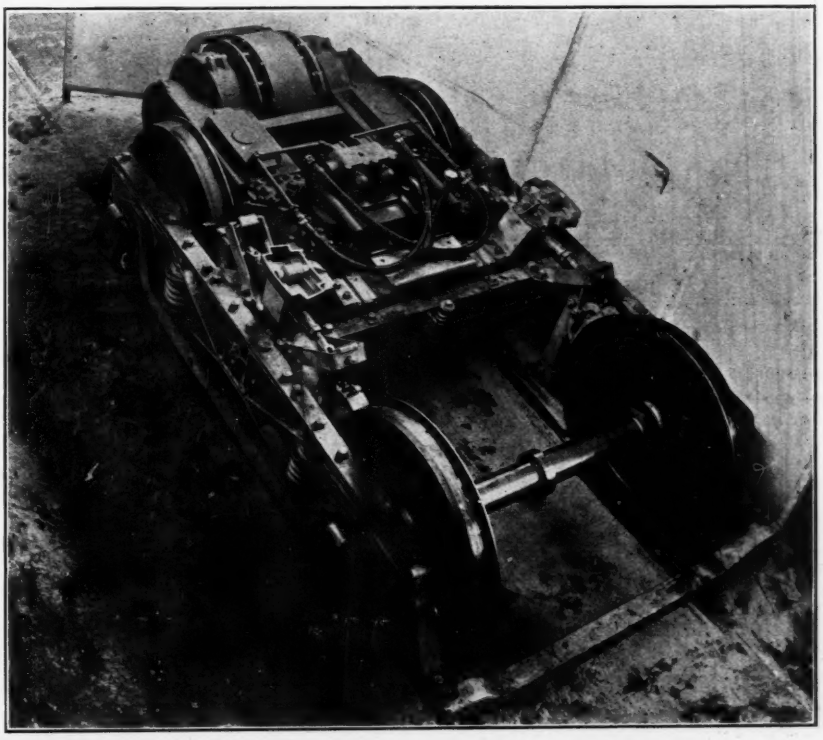


FIG. 5.—VIEW OF FIRST EXPERIMENTAL MOTOR TRUCK.

account of these and other features the electric motors of this system can be much smaller in capacity, when rated as continuous working motors, than those of other systems not possessing this equalizing load feature, and the capacity of the power-house and line can be reduced to about one-half of what would be required with systems where the fluctuating starting loads of the cars are transmitted back to the power-house.

In order to better understand the different operations of the system, Fig. 4, showing a speed diagram, has been prepared, in which on the axis of abscissa ODI are represented the different car speeds in per cent of the synchronous motor speed, while the coordinate axis AOB represents the rotor and stator speeds corresponding to the car speeds shown.

The operation of the car may be divided into the following periods:

I—STANDING IN THE STATIONS.

Referring to Fig. 1 the rotor R is standing still, while the stator S runs with full synchronous speed. The stator is then transferring the full energy of the electric motor through crank C to the compressor cylinder SC, which energy is being delivered in form of compressed air into the air reservoir.

Since the relative velocity between the stator and the rotor is, under all conditions of operation, constant, the speed curves of stator and rotor may be represented by two parallel lines O, CR and ADS in Fig. 2. The origin O of the given coordinate system represents the period of rest of the car, and, therefore, indicates zero rotor speed and full stator speed in a negative or downward direction, as the stator is now revolving in the opposite direction from that which the rotor must revolve to drive the car forward.

Let it be further assumed that for an instant OA equals the active torque of the stator, then it will be easily understood that OB which equals OA represents the reactive torque of the rotor exerted on the car axle, meaning that if the car is free to move the reactive torque can be used advantageously for the starting and acceleration of the car.

When the car is standing in a station it is held at rest by moving the controller to such a position that the outlet pipe from rotor cylinder RC is throttled, thereby increasing the pressure behind the piston to such an extent that it overcomes the effort of rotor R to revolve, thus tending to cause the stator S to revolve and at the same time holds the car at rest without the use of wheel brakes.

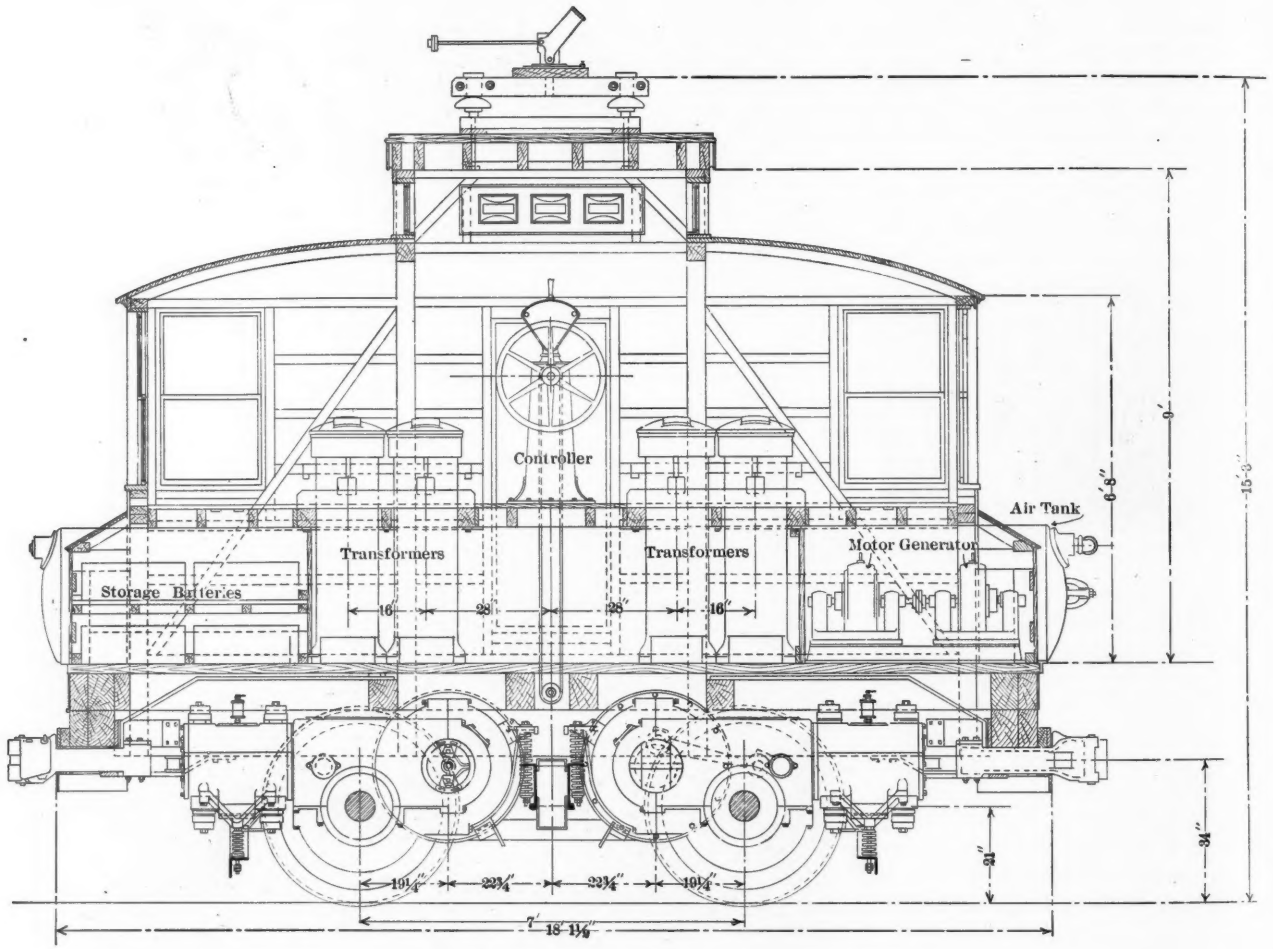


FIG. 6.—LONGITUDINAL SECTION OF LOCOMOTIVE.

II—STARTING AND ACCELERATING.

To start the car, the air cushion behind the piston of RC is removed and the air which is being compressed by cylinder SC, supplemented by the stored air from the tanks, is admitted to cylinder RC, with the controller at the position of maximum cutoff. The rotor then begins to revolve, and as it accelerates the stator slows down by exactly the same amount that the rotor has increased its speed, and as the rotor and car speed increase the controller is gradually moved to a smaller

percentage of cutoff, until the car speed corresponds to the full synchronous speed of the motor, at which time the stator comes to rest.

During this period of acceleration the air compressed by cylinder SC, instead of being delivered to the tanks to lose its heat, is delivered, hot, directly to the rotor cylinders, thus greatly increasing the efficiency of the combination, as the heat usually lost in air systems is utilized and the advantages of heated air gained without a reheater, and as the pressure used is low many of the ordinary difficulties in the use of compressed air disappear. If the rate of acceleration is such that cylinder RC uses all of the air supplied by cylinder SC no exhaust to the atmosphere from cylinder RC takes place.

Referring now to Fig. 2, which graphically represents this process, since the electric motor runs always at a constant speed and a constant load it has a constant torque, and, therefore, the distance between lines OCR and ADS may be considered as representing the energy delivered by the electric motor.

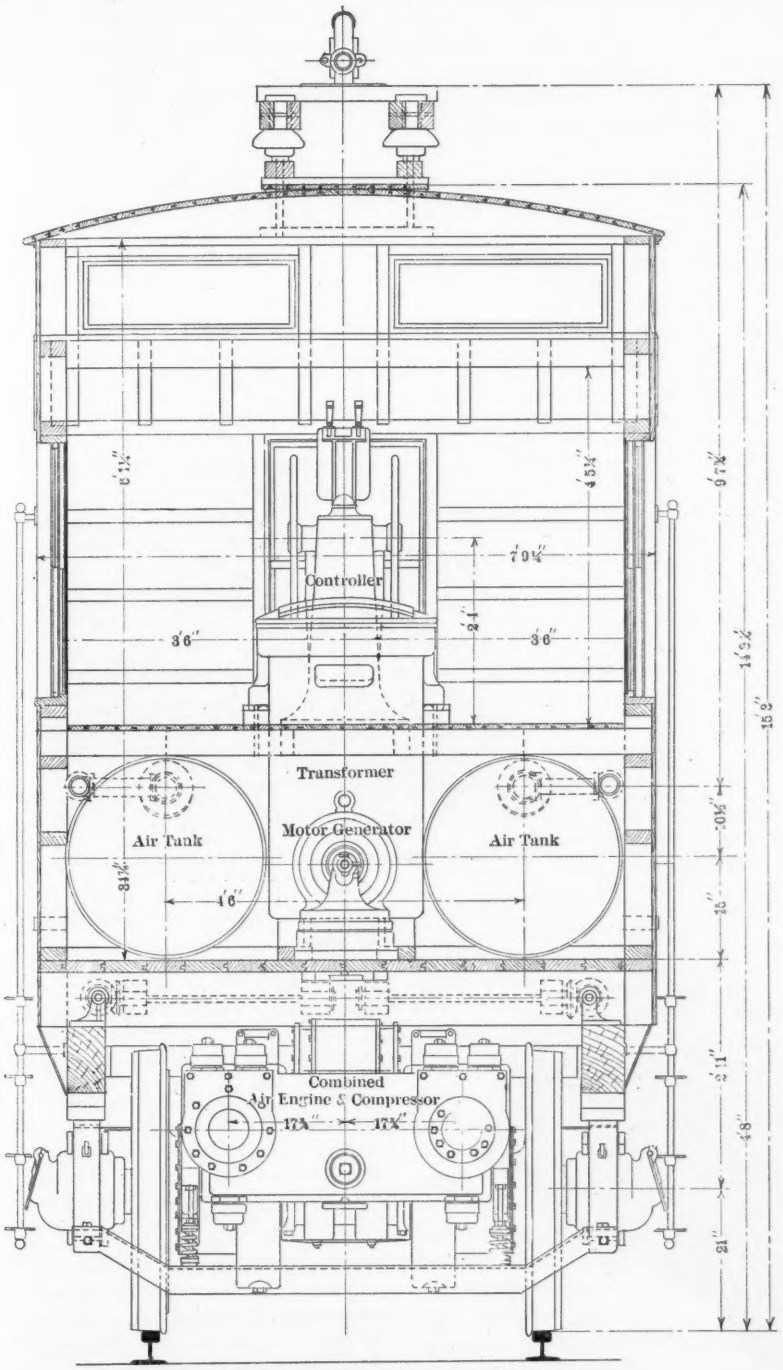


FIG. 7.—TRANSVERSE SECTION OF LOCOMOTIVE.

The length of any ordinate extending from OD to OC represents the proportionate amount of energy derived from the electric motor, which is applied directly through pinion P and gear G of Fig. 3 to the propulsion of the car, while the corresponding ordinate extending below OD and AD represents the proportionate amount of the energy of the electric motor which is absorbed in compressing air through cylinder SC, which energy, in the form of air, is immediately transferred to cylinder RC and is utilized in accelerating the car.

In practice, however, since there will be a loss in transferring the energy from electrical energy into energy in the form of compressed air and back again into mechanical energy, this loss, whatever it may be, must be drawn from the storage tanks, and the requisite amount of air from these tanks supplied to rotor cylinder RC in order to maintain the full power of the electric motor upon the car axle during the period of acceleration. Should it be desired to accelerate at a greater rate than the full power of the electric motor is capable of giving to the car, the additional energy may be supplied in the form of air from the storage tanks through cylinder RC, thus increasing the total energy given to the car during acceleration, in which case this total power would be represented for any given instant by a point above line RC.

III—FULL SPEED.

When the rotor has reached full synchronous speed, by the previous operation, this speed can be maintained by moving the controller to another position which will throttle the outlet pipe of cylinder SC until the reaction due to the pressure behind the piston equals the full capacity of the electric motor. An overload or underload may be placed upon the motor by varying this pressure, but under normal conditions of operation cylinder SC is provided with an automatic valve which keeps a constant pressure behind its piston, thus maintaining an absolutely constant load upon the electric motor and consequently a uniform demand of electrical energy from the line. This uniform load is represented by the parallel lines OCR and ADS of Fig. 2.

With the controller set at full speed position the inlet valves of rotor cylinder RC are held open and the piston runs free and the electric motor now gives its full power to the car axle, and the stator and its air mechanism will remain at rest as long as the car runs at the speed corresponding to the synchronous speed of the motor.

IV—SPEED VARIATIONS.

There are usually certain places on any road where high rates of speed can be maintained for short distances, and as these speeds might be higher than the synchronous speed for which the motor was designed they are provided for as follows:

Assuming that the car is running at synchronous speed, the controller may be

moved to such a position that the valves of stator cylinder SC operate in such a manner as to cause it to act as an engine and revolve stator S in the same direction as rotor R is revolving. This now causes, owing to the constantly electrically maintained relative difference in speed between the stator and the rotor, an increase of speed of the rotor and car axle, due to the motor automatically working as a magnetic clutch, without mechanical contact, and if the resistance of the car or train is less than the capacity of the electric motor the air necessary for revolving the stator can be obtained, hot, from the rotor cylinder RC without drawing from the tanks and a speed above synchronism, indirectly proportional to the resistance of the train maintained indefinitely. When the resistance of the train is greater than the capacity of the electric motor, speeds above synchronism can be obtained only by supplying rotor cylinder RC with stored air from the tanks and can only be maintained for short distances, or until the storage capacity of the air reservoirs is exhausted. This condition corresponds to the spurts that can be made by a steam locomotive when working above the steaming capacity of the boiler. The distance from the line ODL to that portion of the line ADS above ODL in Fig. 2 represents, at any given speed, the proportionate amount of energy which must come from the tanks and be supplied through cylinder SC, and the distance from DL to CR represents the total energy given to the car by the combined action of the electric motor and the stator cylinder when operating under these conditions.

The energy delivered to the car can be still further increased by admitting air into rotor cylinder RC and allowing it to work as an engine.

V—RETARDATION.

To bring the car or train to rest, instead of applying mechanical brakes to the wheels in the ordinary manner and thereby dissipating the entire stored energy of the car or train in the form of heat, this energy is saved in the form of compressed air, to assist in starting the car or train, by setting the controller in such a position that rotor cylinder RC compresses air and delivers it into the storage tanks. Any desired rate of retardation can be secured by throttling the delivery pipes from rotor cylinder RC and in practice this pipe is provided with an automatic valve which releases just before the slipping point of the wheels, thus allowing the motorman to brake as rapidly as he desires without liability of flattening the wheels. Supplemental wheel brakes are provided for emergency, but need not often be used, and the ordinary wear and tear on them is saved. When the car is again at rest the cycle of performance as above given is repeated for the next run.

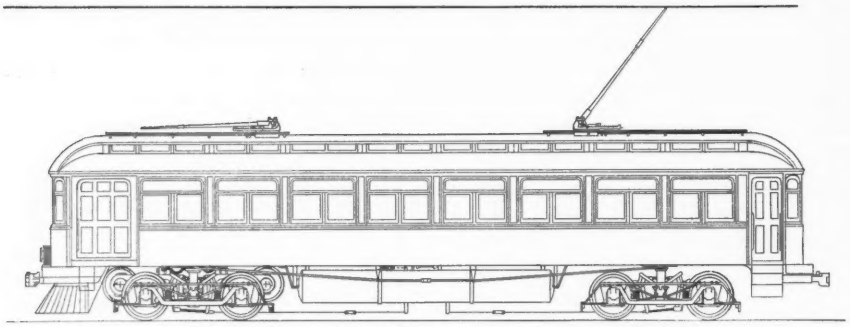


FIG. 8.—LONGITUDINAL DRAWING OF COMPLETE CAR.

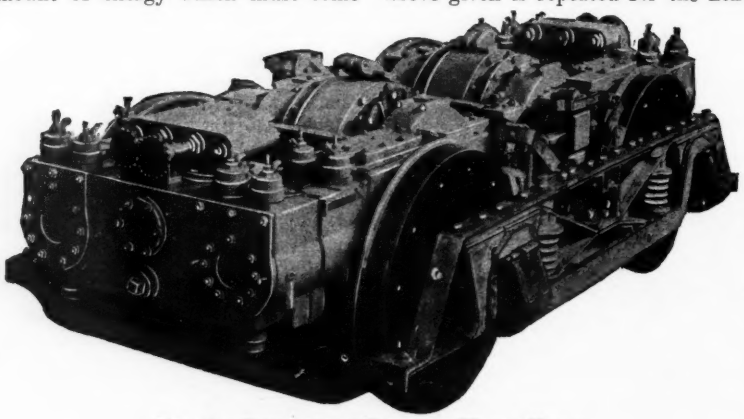


FIG. 10.—COMPLETELY EQUIPPED MOTOR TRUCK.

VI—REVERSING.

When it is desired to run the car backward for short distances the electric motor is not disturbed and the power is furnished by the rotor cylinder RC by reversing the action of the valves, but if it is desired to run backward for any great distance the current is thrown off the motor, the stator engines reversed, and the stator brought to speed by the air, when the current is again thrown on to the motor, and the cycle of operation is the same as when running forward.

Fig. 3 represents the exterior of the electric motor showing the cranks of the stator and rotor, also collector rings for operating the valves of the air cylinders when working as engines.

Fig. 4 shows an interior view of the stator of the motor with the flange removed, the rotor of the motor being of the standard squirrel-cage induction type.

Figs. 5 and 6 show, mounted upon a truck, the views of the first electro-pneumatic motor constructed, and upon which the first experiments were conducted. The design of this car upon which this motor was placed is shown clearly in Figs. 8 and 9.

Since the single motor represented in Fig. 5 was too small in capacity to propel so large a car, it was decided to experiment with an improvised locomotive, consisting of the truck and motor shown in Fig. 5, carrying suitable air tanks and transformers upon a temporary frame structure.

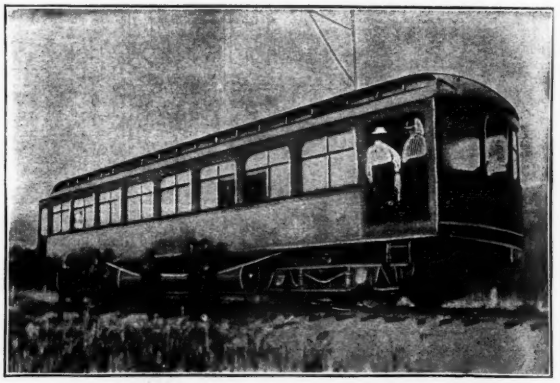


FIG. 9.—EXPERIMENTAL CAR FITTED WITH MOTOR TRUCK AND AIR TANKS.

After the preliminary experiments had been made on the first motor, for experimental purposes a truck was fitted up in the form of a locomotive as shown in longitudinal and transverse section by Figs. 6 and 7, and it was this locomotive that was recently destroyed by fire. In order that the locomotive might operate as an independent air unit upon tracks not equipped with overhead electrical conductor, it was provided with a small storage battery and small motor-generator for charging the batteries and for operating the headlight. These auxiliaries are not necessary for the successful operation of the system, provided the locomotive can always be supplied with electric current from the working conductor, for then the valves can be made to operate from alternating current and thus eliminate the use of motor-generator and batteries. This locomotive was provided with all necessary testing instruments and had been operated in the barns for some time and found to perform all its functions successfully, and would have been placed on the road and experiments with it would now be in progress had it not been destroyed.

AUTOMATIC APPARATUS FOR REGULATING GENERATOR AND FEEDER POTENTIALS.[1]

BY E. J. BECHTEL.

Since the introduction of electricity as a source of illumination, one of the most important problems has been that of potential regulation. There are a number of types of automatic generator potential regulators using different methods to accomplish the result. One type, the connections of which are shown in Fig. 1, has been in use in our station for the past four years on generators up to 250-kilowatt capacity operating under extreme conditions, and has given excellent service in alternating work.

This type of regulator, while very satisfactory as a generator potential regulator, and perhaps sufficient under favorable line and load conditions in small stations, does not correct the potential for variation in power-factor nor relative changes in the load on different feeders.

The system was adopted while our alternating load was comparatively small and operated from single-phase generators. With the intention of operating three-phase power circuits, we replaced the small single-phase generators with larger ones of three-phase, 4,000-volt, four-wire type, the armature being star-connected with neutral connection brought out.

The 2,300-volt single-phase lighting circuits are connected to the different phases and neutral, balanced as nearly as possible between the different phases in regard to load conditions. Even with extreme care, a perfect balance can not be maintained on account of variations of load at different times on the individual circuits. To overcome this, we have ordered nine automatic feeder potential regulators of the boosting transformer type, having the secondary winding in series with the circuit and divided into small sections which are capable of being automatically cut in or out, step by step, as the conditions require, to maintain a desired voltage at the individual feeder terminals. These regulators are to have necessary capacity to maintain a pressure of ten volts (200 volts primary) above or below that of the bus-bars. The installation of this apparatus has been delayed by the manufacturer on account of trouble experienced from pitting or burning of the contacts. I am sorry I am not able to show results of tests on this apparatus and describe its action under practical conditions, as I had intended to do.

Feeder potential regulators are not advisable for use on direct-current systems on account of its being necessary to use batteries, rotary boosters, or dead resistance in series with the different feeders. Any one being a most inefficient arrangement.

However, this problem is not so serious, as the entire system can be formed into a network and operated as one unit. Good distribution and regulation can be obtained by the use of a system of interconnected mains, tied together wherever possible with feeders from high and low bus-bars to determined points, and by use of main storage batteries.

The automatic generator potential regulator first described as being satisfactory on alternating work, was not satisfactory on a direct-current three-wire system. We installed two of these regulators on a pair of 200-kilowatt generators for the purpose of steadying the potential of a three-wire system of about 2,000 kilowatts at peak load; but they are not capable of doing this, nor even capable of maintaining a potential regulation of less than from two to four per cent of their capacity while operating on a separate load. The greatest fault is the tendency to surge or pump (even with a properly adjusted oil cushion), probably on account of the greater sluggishness or time required to increase or decrease the magnetic density of the solid field-poles of the direct-current generator, as against the laminated ones of the alternator. I believe, however, that a later regulator now on the market is capable of maintaining a uniform potential under these conditions, being quicker in its action; as, instead of cutting small steps of resistance, step by step, in or out of the field-circuit, it cuts a large resistance instantaneously in or out of the field circuit, and reverses the operation when the potential rises or falls above or below the normal, repeating this performance as often as required. On large generators this regulator operates upon the fields of the exciter instead of on the fields of the main generators.

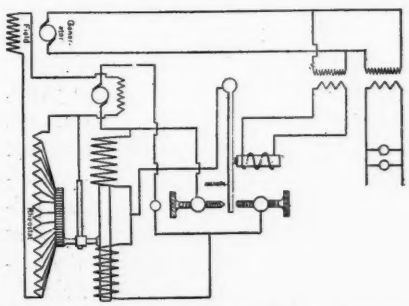


FIG. 1.—CONNECTION FOR AUTOMATIC GENERATOR POTENTIAL REGULATOR.

We have now under consideration the installation of twenty-five-cycle alternating-current generators of large units, to operate synchronous converters for both the street railway and direct-current lighting systems. This is more complex than the first condition, as the sudden variations of the railway load will have its influence upon the regulation of the generator as well as on the speed of the prime mover. We hope, however, to find a regulator which will maintain an even voltage at the generator terminals under these conditions, and allow us to operate shunt-wound synchronous converters from them and in multiple with our present shunt-wound generator on the direct-current lighting system; also to operate synchronous converters from the same units and in multiple with our present compound-wound direct-current generators on the railway system, by means of series inductance and compound winding on the rotary fields.

[1] Abstract of a paper presented at the 183d meeting of the American Institute of Electrical Engineers New York, December 18, 1903.

Improvement in the Kelvin Compass and Sounding Machine.

Several improvements in the design and construction of Lord Kelvin's patent compass and sounding machine have recently been introduced. In the newest form of the compass, illumination is effected from below, and either oil lamps or electric light may be used. The bottom of the compass bowl is in the form of a thick strong lens, through which the light is refracted on the card. The intensity of the light may be varied at the pleasure of the observer, and this is found to be useful in taking bearings of stars or other faint lights.

A new anti-vibrational suspension has been designed, which ensures steadiness in the card, and a new form of helmet, with rifle sights, facilitates the work of taking bearings.

With the new helmet, navigators are able to take bearings of lights and stars by night, with the same ease and convenience as bearings of the sun can now be taken by day.

The new form of sounding machine has been constructed of a height which has been found, from practical experience, to be the most suitable for winding in the line. In addition to this advantage, the new machine has an improved form of brake action; and a further advantage is that the working parts of the machine are all in sight and can be easily removed if necessary.

SAFEGUARDS AND REGULATIONS IN OPERATION OF OVERHEAD DISTRIBUTING SYSTEM.[1]

BY W. C. L. EGLIN.

When it is considered that an overhead distributing system is subjected to many varied conditions, such as the weather, extreme changes of temperature, extraordinary storms, interference from other lines, interference by building operations, excavations, fires and other casualties, and sometimes a wilful interference by the public (not to overlook the small boy with a stone), it should be readily appreciated that all of these varying conditions must be considered in the construction of the line. There are two divisions of conditions: first, the mechanical or structural features, and secondly, the electrical features.

The first group will include the study of the territory in which the line is to be run, width of streets, kind of buildings, height of buildings; other distributing systems, possibilities of interference with these systems; amount of power to be transmitted, and whether the system consists of a simple power transmission circuit, or one complicated with distributing mains covering the larger part of the territory occupied by the transmission system.

Also to be considered are the weather conditions: wind-storms, rain-storms, sleet-storms, snow-storms, lightning-storms, and the changes in temperature from summer to winter. The method of erecting the conductors so that they can be properly repaired or additions made without endangering the lives of the men engaged in this work must be carefully planned. Unless these various points are all considered in the construction of the lines, no rules or safeguards for their operation will be of material benefit.

The second group includes the electrical requirements: the conductors, the insulating method of support, and the means provided to take care of any undue disturbances due to lightning or other causes on the line, such as lightning arresters, fuses, switches, etc.

SPECIFICATIONS FOR MATERIAL TO BE USED.

All of the material entering into the construction of a transmission system should be ordered under specifications which shall clearly set forth the character of the material to be used and also that all of the material will be inspected before it is used on the work, and that tests will be made of samples of all material furnished. The more general requirements are as follows:

Poles—Poles should be as short as possible to meet the conditions and preferably made of good sound chestnut. Southern cedar and pine poles are sometimes used when chestnut is not obtainable. It may also be necessary to use iron poles under certain conditions; but iron poles are to be avoided, principally on account of danger to linemen and also to the short life of the pole, due to rusting. The pole should be roofed at the top to form a right angle, and gained to form a flat of about five inches for the attachment of the cross-arms.

All poles, upon which are located devices requiring regular inspection, should be provided with steps in order to facilitate this work. Spacing of the poles should be carefully considered and should not exceed from forty to forty-five yards. End and corner poles should be braced, and at least every tenth pole throughout the line should be guyed with one-quarter-inch or three-eighths-inch stranded galvanized wire. Regular inspections, at least annually, should be made of the conditions of the poles, which is most readily determined by examination at the base of the pole. When poles are used as junction poles, that is, when lines are run at right angles and attached to the same pole, special care is necessary. A separate drawing should be made of all such poles, showing the arrangement of the wires—keeping in mind the simplest possible arrangement—as a protection for the men who climb these poles. Switch-boxes, fuses, lightning arresters or transformers should not be attached to such poles, but on the first pole removed from this junction pole. Junction poles can frequently be avoided by the use of two poles, making a "Y" connection of the line. By this arrangement the connections are very materially simplified.

Cross-arms — Cross-arms should be spaced at least twenty-four inches between centres, the top of the first arm being one foot from the top of the pole.

Braces—Braces should be made of galvanized iron not less than one and one-quarter inches by three-sixteenths inch thick and about twenty-eight inches long.

Pins—The pins should be made of locust wood, well boiled in linseed oil, and are preferable for voltages of 5,000 volts and under. For higher voltages, pins should receive special consideration.

Insulators—The insulator on the pole line fulfills two functions, *viz.*, the mechanical support of the line and the insulation. As these conditions vary over a wide range, they must be considered for each condition. This is especially so for voltages of 10,000 volts and over. The two materials of which insulators are usually made are glass and porcelain. The glass insulator is more uniform in quality of material than the porcelain, so that for lower voltages glass insulators are recommended. For higher voltages, porcelain insulators are preferred for the following reasons: greater mechanical strength, better insulating qualities, and greater ability to withstand severe weather conditions.

Insulators of high voltages should be made up of a number of insulators cemented together so as to obtain more uniform insulation and to increase the factor of safety from defective manufacture. Before being used, each insulator for high-tension work should be tested at voltages in excess of the operating voltage.

The method of attaching the conductor to the insulator should be carefully considered; first, to see that the wires can be properly fastened to the insulator, and secondly, to see that the strain is transmitted without a twisting or bending strain in the insulator; the only strain permitted should be in compression.

The method of distributing the wires on the pole lines depends on the number and character of the various circuits to be installed. For all voltages below 6,000 volts, the wire should be brought out of the station through long porcelain tubes, properly supported; the various circuits being grouped together, but well spaced, and preferably being distributed in a single, or not more than a double, row of wires. This fan effect allows the circuit to be distributed to the poles without any undue bunching, thus making each circuit easily distinguishable.

The top gain of all poles should be left vacant so that guard-wires can be placed at any point on the line, should they be required. The transmission circuits, which are alive twenty-four hours per day, should be placed on the top arm; that is, the trunk lines should occupy the position where there will be the least liability of coming into contact with the other wires or with the men working on the poles. All other circuits should be placed below series arc circuits, occupying the lower arms, the distributing series circuit being placed on the house of the lower arms on outer pin occupied by such circuits. The bottom cross-arm should be used for such secondary circuits or low-tension lines

[1] A paper presented at the 182d meeting of the American Institute of Electrical Engineers, New York, December 18, 1903.

as may be required. Space should always be provided for an extra arm on the pole for the erection of a transformer. Protective devices for each circuit may be classified as follows: circuit-breaker, fuses for branch circuits, and lightning arresters. Also indicating instruments as follows: voltmeter, ammeter or wattmeter, and ground detectors.

In the arrangement of the protective devices, it is desirable to locate as many of these as possible in the station or substation, for the reason that they are more readily inspected and kept in perfect working order, which ensures the fulfilling of their functions when required. All circuits of 200-kilowatt capacity or over should be protected by means of oil circuit-breakers in preference to fuses, on all voltages over 1,000 volts. These circuit-breakers should be attached to both ends of the line, when two or more feeders are used and connected to the same bus; and there should be no other circuit-breaker or fuses which are automatic in action placed at any other part of the line. Small branch circuits may be taken care of when necessary by fuse boxes, placed upon the first pole of the branch circuit. These fuse boxes, however, should be avoided whenever possible. This can be accomplished by making a branch circuit about the same as the main circuit, depending entirely upon the circuit-breaker in the station to protect both lines. When small branch circuits are desired, place such fuse boxes. These preferably should be an enclosed fuse of the cartridge type mounted on a porcelain base, the whole enclosed in a fireproof and water-proof compartment. This is usually an iron box with a cover and rubber gasket, clamped so as to make it water-tight.

Lightning Arresters—Lightning arresters should be installed at both ends of the line, in the station and substation, on each conductor. Special care should be used in their installation, and provision made that in the event of a breakdown of the lightning arrester, current may be interrupted by means of a circuit-breaking device.

Series Arc Loop Cutouts—These should consist of a mechanically operated switch which closes the circuit at the point of the loop and disconnects the loop from the main line. For the use of constant-potential circuits, there may be either a fuse-box provided with solid catches or fuses depending on the conditions. All of these devices being enclosed in fire and waterproof cases.

Before considering the actions of the safety devices, it is necessary, first, to examine the faults which may develop and the functions which the safety devices are required to fulfil. If the condition of a wire parting is first considered, we have first the liability of the wire coming in contact with some of the other circuits; secondly, its liability to fall into the street, and thirdly, its remaining suspended clear of all circuits and the ground.

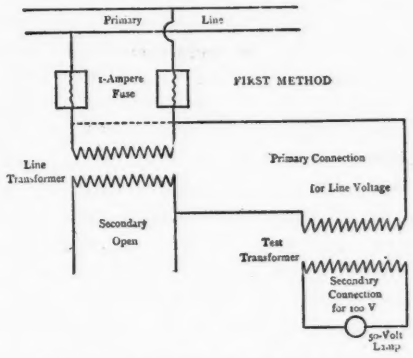


FIG. 1.—METHOD FOR TESTING LINE TRANSFORMER.

The first condition: the effect of coming in contact with other wires would immediately raise the voltage to the more powerful of the two circuits, so it is evident that the insulation of the other circuit must either be as good or there will be a liability of the insulation breaking down at some point on the weaker circuit. This will first be detected at the station by showing that the load is dropped from this circuit; and it demonstrates that the insulation of all circuits must be the same when placed on the same pole line, unless means are provided to take off extraordinary high voltages. This can be done by placing spark-gaps, which will relieve the high-tension from any low-tension circuits, or by grounding a point on the lower-tension circuits.

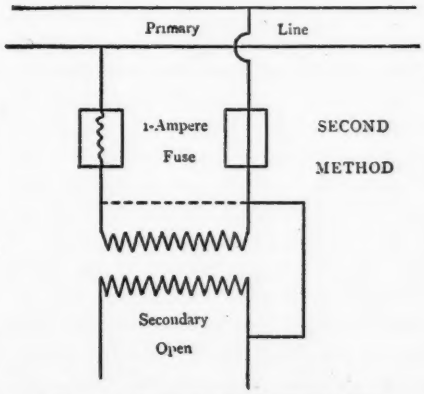


FIG. 2.—METHOD FOR TESTING LINE TRANSFORMER.

Wires falling on the ground will indicate immediately in the station, on the ground detector, that there is a ground on that circuit; and instructions should be given that as soon as a ground shows on the circuit and the circuit is not carrying the load, to disconnect it.

The third condition will indicate in the station that the load is dropped and will not show a ground. The circuit should be cut off in this case also, and inspectors sent out to look after the trouble.

Fourthly; if a wire breaks and falls, crossing other wires of the same circuit, this will cause a rush of current on constant-potential circuit and immediately open the circuit-breaker. In the series arc circuit it will cut out a portion of the circuit which will be indicated on the voltmeter, showing the necessity of regular voltmeter readings on such circuits.

Interference with Other Wires Falling or Coming in Contact with the Power Circuits—If these wires cross the power circuit and drop loosely on them, the effect will be to short-circuit the power circuit on constant-potential circuits; the defect develops immediately. The wires either burn off or an arc may be established which will burn off the power circuit, breaking the wires and the connection. The provision should be as the conditions shown for the breaking of a wire. A single wire may merely come in contact with one wire of a constant-potential circuit and assume the same voltage as that circuit; there will be no way of determining this at either the station or the substation, unless that wire was grounded and the ground indicated on the ground detectors. In the event of this falling wire coming in contact with both sides of the series arc circuit, a portion of the circuit will be cut out and indicated on the voltmeter at the station. Should it come in contact with only one wire of the circuit, no indication will be made at the station unless the wire be grounded. For this reason inspection should be made and all such wires changed so as to come below the power circuit and not above it. This also demonstrates the necessity of placing protective devices on foreign wires which may come in contact with power circuits.

Lightning-Storms—The installing of efficient lightning arresters as specified may protect the apparatus at both the generating station and substation, but fail to protect apparatus at intervening points, particularly the transformers. It is possible that lightning may jump from primary to secondary of transformers during a severe storm. This would be indicated by the primary fuse blowing in the transformer; and after the blowing of

the fuse from this cause, tests should be made of the transformer as follows:

It is essential that when a primary fuse on a transformer is blown through any cause, the secondaries should be disconnected from the transformer, and the latter tested to full line voltage between the primary and secondary coils, so as to determine that there is no breakdown in the insulation between these coils.

There are two methods by which these tests may be readily made by the linemen without removing the transformer: first, take from the station a 600-watt transformer, connect its primary for the line voltage and its secondaries for 100 watts, and connect a fifty-volt lamp across the latter. Attach one primary lead of this test transformer to one secondary wire of the line transformer, and place one-ampere fuses in the primary cutouts protecting the line transformer. Now connect the other primary lead of the test transformer, first to one and then to the other of the main primary lines. If the fifty-volt lamp filament becomes red, the line transformer is defective, and should be returned to the station. Second method: if impossible to use the first method, proceed as follows, attach a short piece of heavily insulated rubber wire to one of the secondary wires leading from the transformer. Then place one-ampere fuses in the cutouts, and connect the specially insulated rubber wire first to one and then the other of the main primary lines. If the fuse blows, or a spark shows when contact is made, the transformer is defective and should be removed from the line.

In the event of lightning arresters being placed on the pole line, all such lightning arresters should be inspected after each heavy lightning-storm.

Transformers—Transformers when supported on the poles should be hung on an extra cross-arm provided for that purpose. The primary leads from the line to the fuse-box and to the transformer should be insulated with rubber-covered braid, for the line voltage. Transformers should not be attached to buildings or in such locations as to be handled by unauthorized people, and when they are placed in buildings they should be put in a separate fireproof closet or room which is controlled only by the operating plant. As it is now the general practice to use oil transformers it is unnecessary to consider dry transformers. Inspection should be made to see that the cases are properly filled with oil. This should be done by an inspection force, and not by the men erecting the transformers.

Inspection—The greatest safeguard in a transmission line is regular inspection. Lines can with advantage be inspected daily, not only an inspection from the ground, but a regular monthly inspection of all devices attached to the line when a continued service is desired.

It may be necessary on some parts of the line to introduce cable. This should be avoided whenever possible for the reason that the conductors are brought close together at this point and static discharge is liable to puncture the insulation; so means should be provided at both ends of the cable to take care of the static. This is best arranged for by a series of gaps of the lightning-arrester type. Standard lightning arresters can usually be used for this purpose. They should, however, be provided with a small fuse in series with the connection to the line so as to prevent short-circuiting the lines in case of failure of the spark-gaps.

Gilbert, of Colchester, Father of Electrical Science.

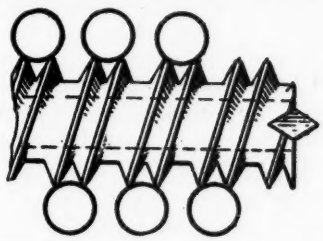
By the publication in 1600 of the "De Magnete" of Dr. William Gilbert, the science of electricity was founded. The author was born on May 24, 1544, was educated at the Colchester school and St. John's College, Cambridge, where he became mathematical examiner and senior bursar. He graduated as doctor of medicine in 1569. After three years of travel and study in Italy and elsewhere, he settled down in London as a physician, in which profession he rapidly arose to eminence. Gilbert founded the entire subject of terrestrial magnetism, made notable contributions to astronomy, and in an age given over to metaphysical obscurities and dogmatic sophistry, cultivated the method of experiment and reasoning from observation, with an insight and success which entitled him to be regarded as the father of the inductive method. Gilbert's contribution to electrical knowledge is contained in the second chapter of his book. These discoveries may be summed up as follows: the generalization of the class of electrics—that is, bodies which may be made to exert electrical attraction. The observation that damp weather hinders electrification. The generalization that electrified bodies attract everything, including even metals, water and oil. The invention of the non-magnetic versorium or electroscope, an instrument similar to the compass, but made of non-magnetic metal. The observation that merely warming amber does not electrify it. The recognition of a definite class of non-electrics. The observation that certain electrics do not attract if roasted or burned. That certain electrics, when softened by heat, lose their power. That the electric effluvia—by which were meant the electric fields surrounding a charge—are stopped by the interposition of a sheet of paper or a piece of linen, or by moist air blown from the mouth. That glowing bodies, such as a live coal, when brought near excited amber, discharge its power. That the heat of the sun, even when concentrated by a burning mirror, confers no vigor on the amber, but dissipates the effluvia. That sulphur and shellac, when aflame, are not electric. That polish is not essential for an electric. That the electric attracts bodies themselves, not the intervening air. That flame is not attracted. That flame destroys the electrical effluvia. That during south winds and in damp weather, glass and crystal, which collect moisture on their surface, are electrically more interfered with than amber, jet and sulphur, which do not so easily take up the moisture on their surfaces. That pure oil does not hinder the production of electrification or exercise of attraction. That smoke is electrically attracted, unless too rare. That the attraction of an electric is in a straight line toward it.—*Electrician (London)*.

The New German Cable.

The first cable connecting Germany and America, by way of Emden, Azores and New York, was laid in 1900, and a second cable is being laid side by side with the older one. The first section of the new cable, extending from Borkum to Horta, in the Azores, as well as the connection between Emden and Borkum, was completed by the end of October. In the first 800 knots of cable the copper employed weighs 500 pounds per naut, and the gutta-percha, 290 pounds per naut. The conductor consists of a central wire 107 mils in diameter, around which are stranded twelve wires thirty-six mils in diameter. In the second length of cable —about 1,150 knots—the conductors weigh 400 pounds, and the gutta-percha, 280 pounds per naut. The middle wire has a diameter of ninety-five mils, and the surrounding wires are each thirty-two mils. The spaces between the wires are filled in with Chatterton compound, and gutta-percha and Chatterton compound are employed in alternate layers, three of each material being used. The insulation resistance is not less than 400 megohms, and the capacity not more than 0.435 microfarad per nautical mile. As protection against terodos, the first length of cable is wound with brass tape.

Electrical Patents.

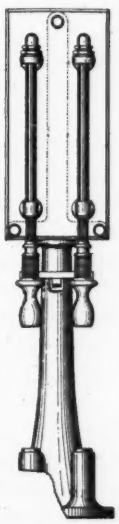
The Consolidated Car-Heating Company, of Albany, N. Y., is the assignee of a patent granted to Mr. James F. McElroy, on an electric-heating element. The object of the invention is to provide an electric heater so constructed that the maximum amount of air may be brought in contact with the conducting-wire, and providing not only for the passage of air through the adjacent layers of the conducting-wire, but for bringing it in contact with the major portion of the exterior surfaces of the coil of conducting-wires, and also to provide a means whereby the several devices for the support of the conducting-wire shall be brought in



Showing Support and Manner in which Conducting Wire Is Coiled on It.

proper relation to each other. A support, preferably constructed of porcelain or other non-conducting substance or of metal coated with non-conducting material, is provided with two spiral ridges extending from one end of the support to the other. In contact with the edges of two of the adjacent ridges is placed a coiled conducting-wire, there being between the adjacent coils, placed on the support spiral groove, space for the passage of air in contact with the exterior surface on each side of the conducting substance and extending throughout the length of the support. The support may also be arranged so that the two spiral ridges differ in their distance from each other, providing a means for placing more or less of the heating element upon the support, if desired, the heating element being placed in contact with the adjacent ridges closer together, making the heater of larger diameter and containing more wire and leaving a wider space between the adjacent layers of the heating element. Means may also be provided for allowing the circulation of air through the heating element by spacing the distance between the ridges.

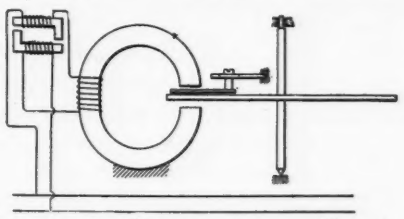
An automatic circuit-breaker recently patented by Mr. Edward M. Hewlett, of Schenectady, N. Y., has been assigned to the General Electric Company, Schenectady, N. Y. The inventor's object is to automatically interrupt the circuit by producing a long quick break. The invention is particularly designed for service in connection with alternating circuits, feeding constant-current transformers. It may, however, be applied generally to any circuits, direct or alternating. In carrying out the invention, one or more gravitative switch plugs are employed, cooperating with circuit terminals mounted upon a fixed support and adapted to slip through the lower terminal and form a good connection with a socket on the upper terminal, a spring being strained in effecting the connection before a detent latch holding the plug in place. A trip is provided for releasing the detent, thereby permitting the spring to rebound, and disconnecting the plug, which drops by gravity and produces a long, quick break, by which the arc is extinguished. In order to avoid damage or injury by the arc or spattering of molten metal and to assist the rapidity of movement of the plug, a tubular inclosure is provided surrounding the plug through a sufficient range of movement to ensure safety. A preferable construction in accomplishing this end, is to mount the tube so as to extend between and form a joint with the respective terminals, the tube, of course, being of insulating material. The trip may be actuated in any suitable way, as by an electromagnetic,



Side Elevation of a New Two-Pole Automatic Circuit-Breaker.

thermal or other device responsive to the condition of the circuit controlled. In regulating constant-current systems, for which the invention is well adapted, a mechanical trip actuated by the movable element of the constant-current transformer, the cooperating portions of this trip and the detent device being adjustable to vary the delicacy of release or the range over which the same may be effected. An improved cup contact for the plug is also provided by which its resiliency may be rendered comparatively uniform, and an effective contact may be made for a long term of service, and by which also a renewal of the contact may be effected when necessary.

George Stern and Albert Lotz, of Charlottenburg, Germany, have patented in this country an alternating-current meter, which they have assigned to the General Electric Company, of Schenectady, N. Y. The object of the invention is to provide a new and improved means for accurately adjusting the phase relation of the flux in the magnetic circuit of a magnet excited from an alternating-current source. In the embodiment of the invention, the core of a potential magnet is mounted on



Diagrammatic Illustration of a New Alternating-Current Induction Meter.

a suitable support, so that its poles include a portion of a meter disc, rotatably supported on a shaft, the complete meter comprising in addition to the parts shown a series magnet and suitable retarding and registering means. An inductance coil is included in circuit with the coil of the potential magnet, this circuit being connected across the mains of an alternating-circuit supply system. The arrangement will operate to produce a shunt magnetization lagging by nearly ninety degrees behind the impressed electromotive force of the circuit to which the meter is connected. In order to increase the phase displacement up to exactly ninety degrees, the inventors provide a fixed body of good conducting material adjustably mounted in the magnetic circuit of the potential magnet. This body of conducting material is in the form of a disc mounted between the poles of the potential magnet adjacent to the armature of the meter, its position being so chosen that it lies symmetrically with respect to a plane passing through the middle of the poles of the potential magnet and the shaft on which the meter-armature is mounted. In order that the disc may be adjusted radially so as to increase or diminish its effect upon the shunt magnetization, it is adjustably secured to a slotted support by means of a screw. By means of this arrangement the result is obtained that the phase displacement of the shunt magnetization may be increased without affecting the magnetization due to the series magnet.

Reviews of Current Engineering and Scientific Literature.

Electric Coupling of Dynamos Driven by Single-Acting Steam Turbines.

An ingenious method of coupling dynamos driven by steam turbines has been developed by the Halske Actien-Gesellschaft, Berlin, in connection with single-acting turbines. For such turbines it has been proposed to allow the steam nozzles to revolve in an opposite direction to that of the moving vanes. By this means two shafts, revolving in opposite directions, are obtained; and with the same relative velocity of steam between the two working parts, as in an ordinary turbine, the two shafts have speeds that are half the absolute speed that the shaft of an ordinary turbine would have under the same conditions. It is not necessary that the two shafts revolve at the same speed. They may be coupled so that the power given off by both can be taken from one of them. However, since two dynamos, when operated in parallel, are coupled together electrically, each exerting a reciprocal action upon the other, the two revolving shafts of a turbine constructed as above may be used to drive the armatures of two generators, and a mechanical coupling may be dispensed with. The machines will thus tend to regulate each other, and if they are identical and equally excited, they will revolve at the same speed, and each deliver half the total power. Any variation in the excitation of one will be compensated for by a difference in speed, and, within certain limits, the loads may be distributed between the two machines in any desired proportion. In this turbine it is necessary to supply the steam to the moving nozzles through a hollow shaft.—*Abstracted from the Mechanical Engineer (London), December* 12.

A New Rapid-Writing Telegraph System.

A rapid-writing telegraph system has been developed by Siemens & Halske, in which the message to be sent is written by a machine similar to a typewriter, on a strip of paper which unrolls automatically from reels, for each character an amount corresponding to the letter to be transmitted. Perforations are punched in the paper for each letter, and at the same time an ordinary character is printed on the band, so that the message thus prepared is legible to the public. The band of paper thus prepared is passed to a rotating telegraph transmitter, and the message automatically sent over the line. The apparatus has a speed of 2,000 letters per minute. The receiving apparatus consists of a wheel, on which the different characters are printed, and which revolves at 2,000 turns a minute. By means of electric sparks and a band of sensitive paper, which passes before the disc, the character which is presented toward the paper at the moment that the spark passes is photographed. The band of paper is then passed under sponges moistened with a fixing solution, and in nine seconds is ready for delivery. The receiving apparatus is simple, and revolves in synchronism with the transmitter. It is controlled by five relays of special construction which allows them to follow without difficulty the very rapid electrical impulses sent over the line.—*Translated and abstracted from Electro (Brussels), November.*

Wind Pressure on Telegraph Structures.

There is no uniform agreement among engineers in charge of line construction as to the force exerted against cylindrical poles and wires by the wind. In this article, Mr. F. W. Jones brings together the various rules in use in this country and abroad, showing how practice differs. S. P. Langley gives the following formula for computing the resistance in pounds offered by a plane surface: $R = K A V^2$; R being the resistance in pounds; K, a constant equal to 0.00166; A, the area in square feet of one side of the plane, and V, the velocity in feet per second. Langley states that the resistance encountered by a cylinder in a wind normal to its side is one-half the resistance which would be encountered by a plane exposing an area equal to its longitudinal section; but small wires and cords have been found by experiment to offer a resistance of from five to ten times what would be given by the above formula. In England, Gavey, the engineer in charge of the British telegraphs, calculates the strength of the average structures and wires to withstand, at right angles to the wind's direction, a pressure of seventeen pounds per square foot. He takes two-thirds of the diameter into the length of the round poles and conductors, as the approximate area affected. The British table of wind pressure requires a velocity of sixty miles an hour to give seventeen pounds per square foot, whereas a table furnished by C. F. Marvin, of the United States Weather Bureau, shows that, to exert an equal pressure, the wind should have a velocity of eighty-five miles an hour. Burne, of the Indian Government telegraphs, experimented by swinging flat and cylindrical plates of exactly equal weight, and lengthening the cylindrical plate until the amplitude of swing of both was the same. He found that the cylindrical surface was a little less than twice that of the plane surface. In India, two-thirds of the diameter, multiplied by the length, is used in calculating wind pressure area of poles and wires. Kernot, of Melbourne, demonstrated by experiment with heavy air blasts, that the pressure at right angles on a cylindrical surface was about one-half that on a flat surface of equal diameter, and that the pressure on one side of a cube was only 0.9 of that of a thin plate of equal area. It is important in calculating lines, not to use the average velocity, as they must withstand sudden gusts; and the extra weight and surface due to clinging sleets and snows must not be overlooked.—*Abstracted from the Telegraph Age (New York), December* 16.

Speed Variation of Continuous-Current Motors by Shunt Control.

A method of varying the speed of continuous-current motors by shunt control is generally commented upon as being of very limited application. Mr. H. M. Hobart criticises a number of such statements, and shows that, with proper design, the system of shunt control is not only the most efficient, but allows of a wide range of speed. Were it not necessary to consider commutation, a motor for shunt control would be chosen just as large and no larger than is necessary for the given required output at the lowest speed at which continuous operation is required. Constant position of the brushes at the geometrical neutral point for all loads should be assumed as the desirable basis of operation. In so far as high speeds are insisted upon, the manufacturer must be prepared to incur greater expense in construction, as regards commutator subdivisions, large armature diameter, and otherwise; or the customer must be prepared to be contented with a less satisfactory motor as regards commutation. The author believes that ninety per cent of all the manufacturers of continuous-current motors are spending too

little on their high-speed motors, and are wastefully constructing their low-speed motors. A motor of small diameter and considerable axial length is, for its output, in general, the cheapest to manufacture; but for a high-speed motor, the design must be of relatively large diameter, and short (hence expensive), otherwise the commutation will be defective. On the other hand, a low-speed motor may be of small diameter, and long, hence cheap for its output. The commutation of a given machine depends upon its reactance voltage, and the latter depends upon two factors—the current and the speed. A variable-speed machine must be designed for good commutation at the highest speed and the highest current; or, better, for the highest value of the product of the speed and current which it will be required to carry. Up to moderate values, for the required maximum speed this design may also be the cheapest design, and no rating down will be necessary on account of commutation. The author believes that the accepted standard speeds for motors are too high; that a lower speed would be more favorable to low cost. A comparatively moderate step downward from the speeds at present in use at once renders possible, by suitable design, the production of wide-range, variable-speed shunt motors without extra cost or of special design. The design should also show as high a ratio of length to diameter as is consistent with sparkless commutation, and liberal provision must be made for ventilating ducts in the armature. The results, moreover, can only be obtained when the highest practical commutator subdivision is adopted.—*Abstracted from the Electrical Review (London), December* 4.

Multiple Supply Electric Railway System for Heavy Traffic.

The production of a satisfactory storage battery for railway work would have, according to Mr. W. N. Stewart, a marked influence on the use of electricity for heavy railway work, and he proposes a system in which the batteries are carried on the train itself, and are used in connection with an independent set of motors. In starting from stations and up grades, the battery is called upon to do work in assisting another set of train motors deriving current at high potential, through a third conductor, from a distant generating station. On level track, the battery motors are not used, and on down grades they may be used as generators for braking and charging the battery. The advantages of high line voltage and low battery voltage will be thus secured, the batteries serving merely as adjuncts to a high-voltage line supply, which may be by either continuous or alternating current. In this system the train will be less liable to stoppage from snow and sleet, and will be independent of line troubles, as it can proceed to its destination by means of battery power only. This is an important feature for large railway systems. The use of the battery will also make expensive third-conductor construction at yards and crossings unnecessary. The author estimates that forty per cent of the conductor system would thus be avoided. The system will also reduce the capacity of a generating station forty to fifty per cent, as the use of batteries makes it possible to operate the station at a load factor of 100 per cent. Synchronous converter substations would be unnecessary, and all sections of the road, except those on which trains are running, can be cut out automatically. The author estimates that it would be cheaper by over $3,000,000 to install a system of this kind, using direct current at 4,000 volts, supplied from substations thirty miles apart, for a system such as the Great Western road from Paddington to Plymouth, a distance of 240 miles, than to use a single-phase plant working at 40,000 volts, with stations 120 miles apart. He states that this system will soon have a practical test on a large scale. —*Abstracted from the Tramway and Railway World (London), December* 10.

Sterilization of Water by Ozone.

Methods of sterilizing water, now in use, are here discussed by Dr. Barbier, who believes that the application of ozone for this purpose possesses many advantages. Other methods in use are filtration, which can never give complete sterilization, and heating. If the water is raised to a temperature of 110 to 120 degrees centigrade, and maintained at that temperature for some time, all the pathogenic germs are destroyed. This method would be good, were it not for the excessive cost. Ozone, being an energetic oxidizer, destroys all microbes and oxidizes all organic matter. An installation making use of this method is about to be installed at the Mediterranean breweries, in Marseilles. The ozone is obtained by means of electrical discharges, produced between plates of glass placed about 1.5 millimetres apart. These plates are connected to the terminals of a transformer by means of metallic tubes, through which cooling water is circulated. The transformer is fed by alternating current at fifty volts, and gives at the terminals of the secondary a difference of potential of 40,000 volts. In parallel on the conductors carrying the current to the electrodes of the ozonizing apparatus is placed a discharging air-gap, which is used to regulate the voltage applied to the electrodes, and in this way controls the production of ozone. The electrodes are enclosed in a large glass case, through which air is forced under a pressure of from ten to twenty millimetres of water, by means of a fan driven by a small motor. This air is first dried by passing it over pumice-stone moistened with sulphuric acid. The air then passes up through a tower, in which it meets the water sprayed down from above. The output of the ozone apparatus is measured by a manometer, and the concentration of ozone is tested by iodine solutions. The concentration of ozone is six grammes per cubic metre, and one cubic metre of air sterilizes six cubic metres of water, one gramme of ozone being sufficient to sterilize one cubic metre of water.—*Translated and abstracted from L'Électricien (Paris), December* 12.

Power Development at Kakabeka Falls, Canada.

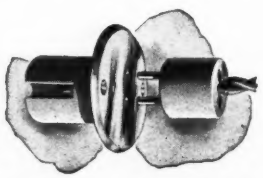
Twenty miles above the town of Fort William, Ontario, the waters of the Kaministikwia river plunge over a precipice 125 feet high, known as the Kakabeka falls. This river carries to lake Superior the water from a water-shed as large as the territory embraced in a line drawn from lake Erie to Georgian bay, and thence westward to the Detroit river. It is the outlet of Shebandowan and Dog lakes, both bodies of water of large size. Five miles from its mouth, the Kaministikwia river is twenty feet deep and 400 feet wide. It is estimated that, if properly developed, 6,000 horse-power of electrical energy would be obtained there. The water rights to this fall have been granted at different times to several individuals and companies, and several plans have been put forward for developing it, but so far all have fallen through. The companies interested have now come to an understanding, and the development of the falls will proceed at once. The power plant will be located there, and the energy generated will be transmitted electrically to Fort William. The company has agreed to furnish the town with power at $18 per horse-power per year, in return for the use of the streets.—*Abstracted from the Canadian Electrical News (Toronto), December.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Midget Receptacle and Plug.

The accompanying illustration shows a new device which has been put on the market by the Marshall-Sanders Company, Boston, Mass. This receptacle, which is designated as the Junior midget plug and receptacle, is similar in many respects to its namesake, the No. 521 midget plug and receptacle, manufactured by the same company. Instead of having



MIDGET RECEPTACLE AND PLUG.

a metal lid or hinge to close over the contacts, the connection is made through two insulated holes in the plate.

This plug and receptacle can be used in nearly all places where a temporary connection is required, as for fan motors, desk lamps, or fixture showrooms; in fact, in all places except floors. A great many of these receptacles are used in base boards and the walls of rooms, and this device is a most economical piece of apparatus. The Marshall Sanders Company has a large stock ready for immediate delivery.

Turbo-Electric Apparatus for Manila.

An important export order has just been closed with the Manila Construction Company, an American corporation conducting operations in the city of Manila, Philippine Islands, for a complete power equipment for the city traction system. The following apparatus is included in the order: three 750-kilowatt Westinghouse turbo-generator units; two compound engine exciter units; one motor-driven exciter unit; three 500-kilowatt rotary converters; one 300-kilowatt rotary converter; four 250-kilowatt oil-insulated transformers; a complete switchboard, and a series booster. This booster is mounted on the extended shaft of one of the rotary converters.

The car equipment will comprise ninety double No. 68 C outfits and ten double No. 56 outfits, using standard Westinghouse controllers.

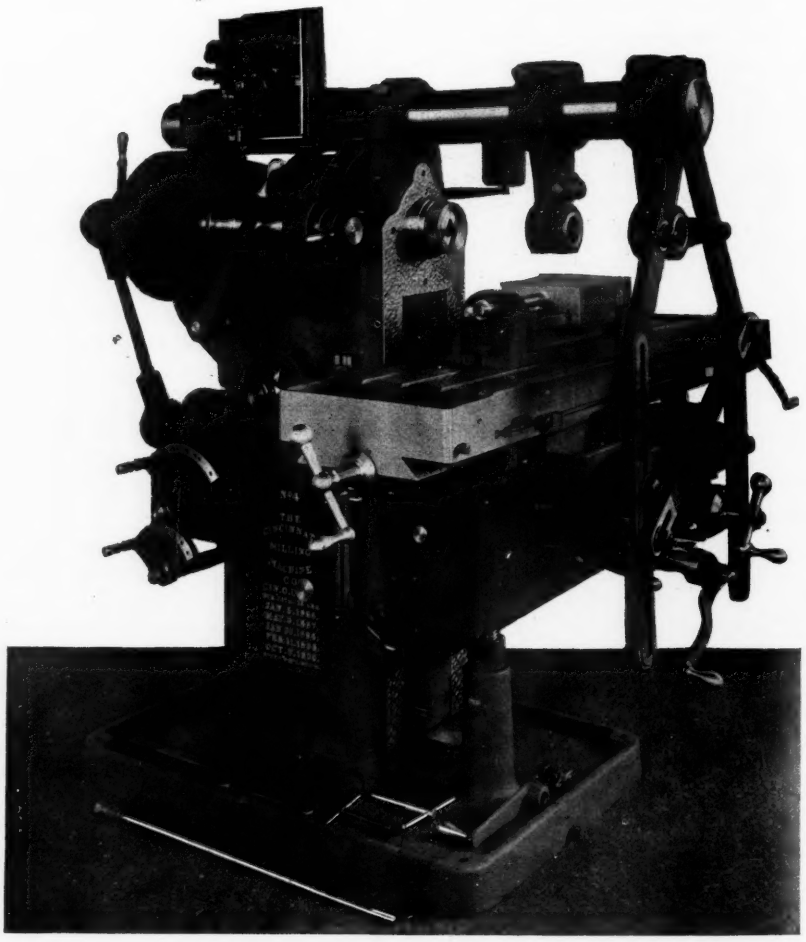
The first turbo-generator unit will be delivered in nine months. The turbine will operate at 150 pounds steam pressure, twenty-six to twenty-seven inches vacuum, and 150 degrees superheat. It will be fitted with the usual by-pass for securing an overload capacity of fifty per cent, and will also be equipped with a quick-closing throttle valve.

The turbo-generators will furnish three-phase sixty-cycle current at 380 volts. Part of the current will be converted to direct current by the power-house railway substation, and the remainder will go to transformers for supplying high-tension distributing system. The transformers are oil-cooled and connected in the two-phase, three-phase or Scott system for three-phase transmission. The turbine machinery will also furnish power to the local light and power system.

This order was secured through Westinghouse, Church, Kerr & Company, New York city.

Electrically Driven Milling Machine.

The accompanying illustrations show a new design of milling machine, motor-driven, which the Cincinnati Milling Machine Company, Cincinnati, Ohio, has recently brought out. The design of an efficient milling machine is quite complex because of the peculiar service to which a milling machine is subjected. The principal points to be considered in the design of such a machine are: (*a*) the wide range and great number of speeds that are now a necessity for economical milling, (*b*) the power consumed, requiring a motor that is very large as compared to the size of the machine, (*c*) the machine must be started and stopped many times a day.

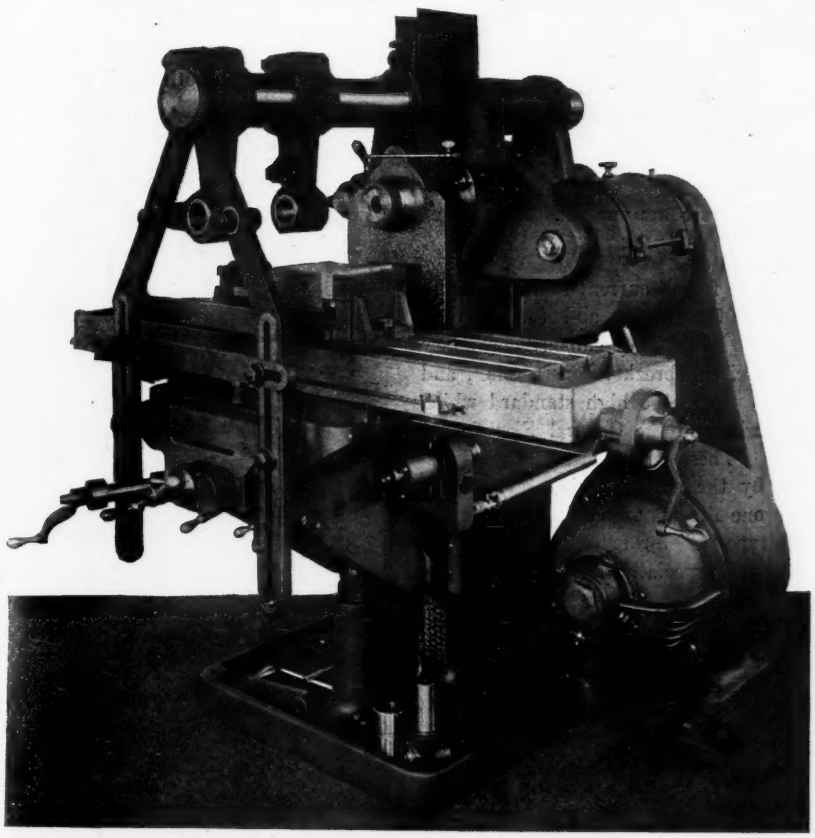


MOTOR-DRIVEN MILLING MACHINE. VIEW SHOWING STARTING BOX AND CONTROLLER.

It is asserted that these conditions have been provided for in the new No. 4 plain miller with motor drive recently brought out by this company. The miller is the

result of some four years of careful study of the problem of electric driving as applied to millers. A number of this company's smaller machines on which a similar arrangement is used are now in successful operation in this country and in Europe.

The design of this machine is based on the conclusion, which is now quite general, that the only satisfactory arrangement of a direct-connected electric drive for machine tools is obtained by the use of some type of variable speed motor, and in this particular case the builders strongly advocate the use of shunt wound direct-current motor operated by a field rheostat. The variation in speeds being obtained from the motor obviates the use of the usual mass of gearing; and the field rheostat has the advantage that when once set to give the desired speed for a particular job, it need not be disturbed when starting the machine or motor, and thus eliminates the trouble that arises from setting the lever to the wrong notch. The illustration shows the manner in which the motor is mounted on an extension which is cast to and forms part of the base of the machine. This brings it near the floor, thereby adding to the stability of the machine, and the entire arrangement being at the rear, occupies space which would not be available for other purposes because it must be kept free to accommodate the table travel. Any one of several well-known makes of motor can be used providing it is shunt wound for a speed variation of two and one-half to one. This is multiplied by the double back gears, giving at the spindle a range of speeds for cutters five-sixteenths to six inches in diameter at a surface speed of twenty feet per minute, and for cutters from five-eighths to twelve inches diameter at a surface speed of forty feet per minute, which is suitable for milling cast iron. It is clear enough that these machines fitted with shunt-wound motors are thoroughly adapted for installation in shops employing the multiple voltage system, in which case they will use only one of the several voltages available, thereby simplifying the wiring and controlling apparatus. Power is transmitted from the motor to a friction clutch and from thence to the spindle by Morse silent chains. This interposition of the friction clutch between the motor and spindle is one of the novel features of the design. By means of it the machine may be started and stopped quickly without stopping the motor, thereby saving that considerable amount of time that would otherwise be lost in waiting for the motor to come to a stop, and when starting, in waiting for the motor to come up to normal speed. This is an item that is usually overlooked. It amounts to a great deal as compared to the cost of running the motor alone while the machine is making short stops for chucking work. The motor can, of course, be stopped at any time by cutting off the current in the one usual way. The illustration shows the arrangement of the automatic release starting box, field rheostat, friction clutch lever, back gear lever, double back gear, as well as all feed-changing and adjusting levers at the front of the machine within easy reach of the operator, who need never go to rear of machine except for oiling. The chain from the motor drives the wheel on the shaft chain and chain wheels to the spindle. The back gears are both keyed into a sleeve which slides on the back gear quill.



MOTOR-DRIVEN MILLING MACHINE. VIEW SHOWING MOTOR CONNECTION, GEAR CASE AND CASING OF POWER TRANSMISSION GEAR.

The friction clutch lever gives the operator as complete and a very much more convenient control of the spindle than he has when driving from a countershaft in the usual way, and it is also convenient for making a partial revolution of the spindle. The Cincinnati Milling Machine Company is prepared to supply any of its back geared machines with this arrangement.

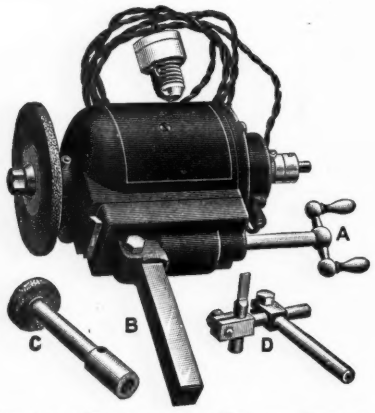
Block Plant for Cleveland.

Cleveland capitalists are about to establish a plant to furnish the heat, light and power for stores and buildings in the city's largest and busiest block. A company called the Central Heat, Light and Power Company has been organized, the chief promoter being H. Whitford Jones, 1013 New England Building, Cleveland. The block to be supplied is bounded by Euclid avenue, Ontario, Sheriff and Prospect streets. In this block are the two largest department stores in the city and many other large stores. The new company has bought land on Hickox Alley, in the centre of the block, and here its plant will be erected. The plant will be erected primarily for the supply of heat, but the promoters hope to absorb the lighting and power service. There are at present in operation in this block twenty-six boilers, all of which will be put out of commission when the new plant is in operation. Specifications for machinery and boilers for this plant have not yet been prepared, and no step toward the purchase of equipment taken. It is the present intention of Mr. Jones to install three large generators.

A Portable Electrically Driven Grinder.

The accompanying illustration shows a portable electrically driven grinder built by the Hisey-Wolf Machine Company, Cincinnati, Ohio. These standard motor grinders are wound for 110 and 220 volts, direct current. Special grinders are wound for from 70 to 250 volts. All of the parts pertaining to the motor are encased in the shell, making it dust-proof.

The spindle carries taper cone bushings running in three-degree and forty-five-degree bearings. They are adjustable to wear by means of a nut on the rear end of the spindle, and are provided with dust-proof caps. The V-slide has a three-inch travel by means of a worm through the handle A, and is fitted with a gib to take up the wear. The shank B is of steel, and is fitted to a hollow in the V cap. It is held in position with the screw, so that different sizes of shanks can be used.



PORTABLE ELECTRICALLY DRIVEN GRINDER.

The extension mandrel C is used for internal grinding by removing the regular wheel and attaching the mandrel in its place. The tooth rest D is a valuable attachment, serving as an index for cutter and reamer grinding.

The grinder has a wide range of work. The shank is set in the tool post of a lathe, planer, shaper or milling machine, and connection made with an incandescent lamp socket, the grinder being sent out supplied with wheels, cord and attachment plug.

The grinder is made in three sizes, of one-quarter, one-half and one horse-power, the weights being sixteen, thirty-five and sixty-five pounds, respectively.

A New Line of Circuit-Breakers.

Some three years ago the General Electric Company placed on the market a line of carbon break circuit-breakers. These breakers have given such satisfaction that the company some time ago decided to extend and complete the line, and has recently placed upon the market several new forms. This new line of circuit-breakers

FIG. 1.—CIRCUIT-BREAKER FOR HEAVY RAILWAY WORK.

is complete for all current capacities from 1 to 10,000 amperes, and for all voltages up to 650. They embody many new ideas in circuit-breaker construction, and are fully up to the high standard which characterizes all the General Electric apparatus. These circuit-breakers are illustrated by the accompanying engravings.

The one illustrated in Fig. 1 is known as the type "C" form "K." This breaker is designed specially for heavy railway

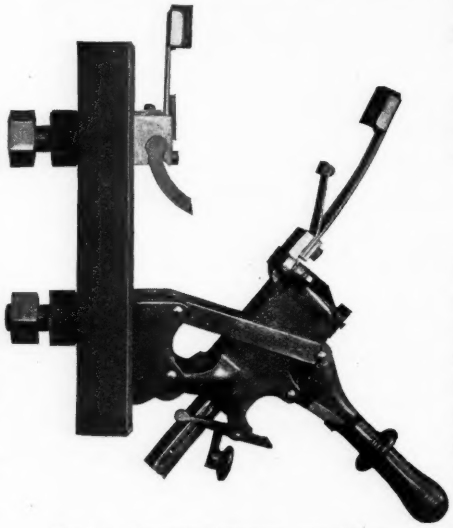


FIG. 2.—CIRCUIT-BREAKER FOR 75 TO 800 AMPERES.

work, and is made in capacities from 800 to 10,000 amperes, and for voltages up to 650 It has been adopted by the Interborough Rapid Transit Company, of New York city, as well as other large companies for use in their power stations. These breakers are very liberally proportioned, both electrically and mechanically, having ample carrying capacity and large contact area. They are very reliable in operation and are designed to close with small expenditure of power.

The type "C" form "M" circuit-breaker, which is illustrated in Fig. 2, like the type "C" form "K," is intended for heavy service, but is of smaller capacity, ranging from 75 to 800 amperes.

The type "C" form "G" circuit-breaker, which is shown in Fig. 3, is compact and simple, yet a very reliable device. It is made in various capacities up to seventy-five amperes, and for voltages up to 650 volts. Its exceedingly low price permits its use in places where switches and fuses have heretofore been used. This breaker is made in both single and double-

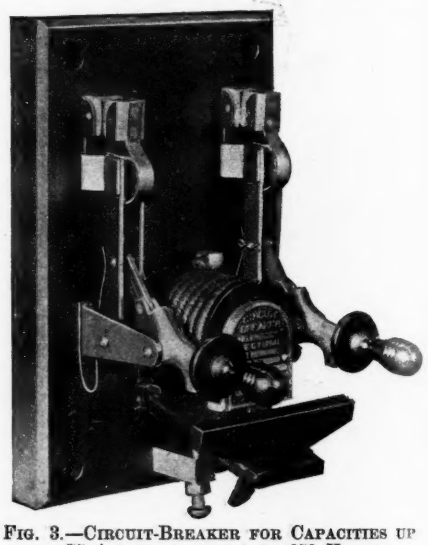


FIG. 3.—CIRCUIT-BREAKER FOR CAPACITIES UP TO 75 AMPERES AND UP TO 650 VOLTS.

pole types, and either pole of the latter may be operated independently of the other.

A Selective Telephone System.

The Nicholas Selector Company, of Rochester, N. Y., is placing on the market an attractive selector for telephone systems. This is the invention of Mr. C. E. Nicholas, now manager of the telephone company, Kenton, Ohio. Mr. Nicholas has been experimenting with this machine for the past two years, and has brought it to its present condition.

An important feature of this apparatus is that it may be used with instruments already installed, and, at the same time, can be used with either bridged or series telephones. In its construction all springs have been omitted, and the operation depends entirely upon the laws of gravitation. The talking circuit is closed and opened by means of a mercury cup. The ringing current for the subscriber's

bell, when operated by central, does not pass through the mercury. The instrument has been designed to work on any bridged system, whether it be a full metallic or grounded system. In the use of the metallic circuit, the selectors are free from ground and less liable to be disturbed by storms or other contingencies.

The equipment in the central office requires the use of a master key in each operator's position, from which the selective lines are operated. The power to work the selector is derived from the same source as the current for ringing the subscriber's bell.

Mr. Nicholas has also designed a system of numbering party lines, so that the operator may understand the necessities of the connection the moment the subscriber calls for a number.

The Heany Enclosed Arc Lamp.

The accompanying illustrations show several views of the Heany enclosed arc

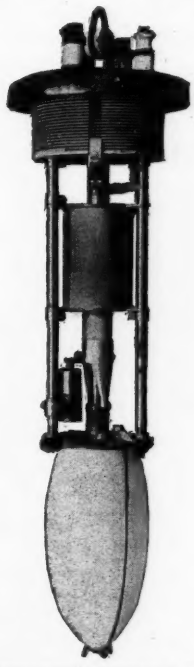
ENCLOSED ARC LAMP, WITH ROUND GLOBE.

lamp for 110 and 220-volt direct-current circuits. This lamp is made by the American Electrical Manufacturing Company, of Philadelphia, Pa.

The lamp frame is composed of three tubes, rigidly supported at the top and bottom. The solenoid coil, which is small and powerful, is held by the three tubes, and is adjustable, provision being made to elevate or lower the coil on the tube in order to adjust the lamp for the amount of current it is to take, or in order that any desired amperage may be obtained.

Extending from the top of the lamp to the base, and within the supporting tubes, is placed another tube. This tube receives the upper carbon and a flexible bond and holder.

Surrounding the carbon-containing tube is placed a combined solenoid core and clutch. This core and clutch con-



SHOWING MECHANICAL DETAILS OF ENCLOSED ARC LAMP.

sist of two semi-tubular members, pivoted or hinged together and arranged to slide up and down on the carbon-containing tube. Each of the two semi-tubular members is provided with extensions downward, having projections or jaws adapted to grip the upper carbon. When the solenoid core is energized magnetically by the coil surrounding it, the semi-tubular members will act as like poles, and repulsion will take place, throwing the extensions with the jaws inward.

THE MAGNETIC CLUTCH.

These jaws grip the upper carbon, and responding at the same time to the action of the coil, advance the carbon in an upward direction, resulting in establishing an arc.

Projecting from the base of the lamp is a support for the carbon receiving tube. This support is tapered to act as a spreading device for the clutch. When the carbons are consumed to such a degree that it is necessary for the lamp to feed, the jaws of the solenoid core and clutch, by descending, come in contact with the tapered projection, and by it are compelled to open so as to positively bring the jaws out of engagement with the carbon, freeing it and eliminating any possibility of sticking.

The solenoid coil is so wound that, should the arc be cut out or the lamp short-circuited, the coil would not be broken down.

The lamp can be readily adjusted to burn on any desired amperage. As there are only two movable parts in the lamp, the possibility of sticking is reduced to a minimum. The combined core and clutch is operated entirely by magnetism, and the clutch permits a wide range in the diameter of the carbons. A projecting

ENCLOSED ARC LAMP, WITH SHADE.

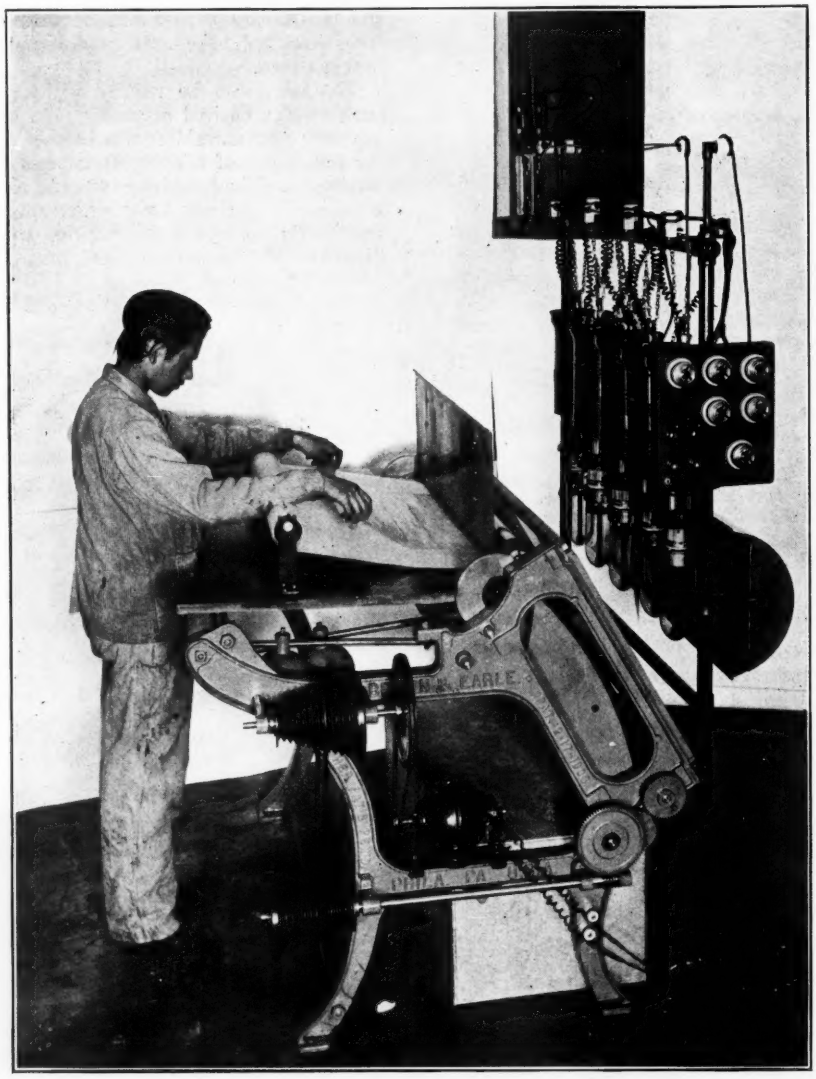
arm is connected to the hinged portion of the clutch, pivotally connected with the dashpot, enabling an easy removal of the dashpot if necessary.

The outer globe-holder has three screws fitted with lock nuts to hold the screws in place after adjusting the globe. It is unnecessary to disturb these screws in removing the globe, as the holder is fitted to the casing with a banded lock, allowing the easy removal or replacement of the outer globe in trimming. Alabaster inner and outer globes are used for indoor lighting. Various combinations of inner and outer globes can be used, and a shade or reflector is furnished if desired, instead of a ball globe.

The casing is constructed of shells drawn from hard sheet copper riveted together.

An Automatic Continuous-Feed Electric Blue-Printing Machine.

The accompanying illustration shows an automatic continuous-feed blue-printing machine manufactured by Williams, Brown & Earle, 918 Chestnut street, Philadelphia, Pa. This machine will make continuous prints of any length, without stop or readjustment. The sensitized paper and tracing are fed in at one end of the machine like a printing-press, and the print and tracing fall into a dark box at the other end. The tension or pressure is automatic, and does not depend on the skill of the operator, and the contact is absolutely perfect. The machine prints as rapidly by night as by day, and is independent of the weather.



AUTOMATIC CONTINUOUS-FEED ELECTRIC BLUE-PRINTING MACHINE.

It will run on any incandescent electric circuit, either 110 or 220-volt direct, or 104-volt alternating.

The operation of the machine is extremely simple. All that is necessary is to feed the tracing and sensitized paper into the machine, and the prints are made and dropped into the box automatically. Should the prints be too light or too dark, the speed of the machine can be adjusted instantly. The machine will handle a tracing one inch, or one twenty-four yards long. A roll of blue-print paper can be run through continuously, and tracing after tracing laid upon it as it passes through without a moment's stop; or separate sheets of any size or shape can be sent through without the use of curtains, levers, springs or pads.

The process of printing is very simple. The tracing and sensitized paper are fed into the machine from the table. The instant they enter the machine, they are automatically clasped by two transparent continuous bands, which travel at exactly the same rate of speed. These bands hold the print and tracing in absolute contact, and they are thus carried in front of the electric lamps, and print as they pass. The speed at which these bands move can be adjusted so as to travel either fast or slow, enabling the operator to print with equal results through the thinnest tracing linen or the thickest tracing or bond paper. The machine is supplied with from three to five electric lamps. These lamps are suspended from an iron frame in such a way that the light from them falls directly on the tracing and sensitized paper as they pass. The print is thus automatically made, without any manipulation on the part of the operator. Each lamp is arranged to pass a small amount of current, making the cost of operation very small.

The continuous bands which carry the sensitized paper and tracing in front of the lamps are actuated by an electric motor which runs on the same current as that supplied to the lamps.

The machine occupies a space five feet square. The manufacturers claim that the chief feature of the apparatus is in its extreme simplicity and in its elimination of cylindrical glass guides, pads or tension springs of any kind. Electrical printing machines are being used in large numbers, in order to get rid of rush work, and also because they are in instant readiness for service, notwithstanding the condition of the weather.

New Incandescent Electric Lamp.

A new electric lamp (Boem's patent) consists of an incandescent body, requiring preliminary heating to render it conductive, and an electric heater. At starting these are connected in parallel, but are afterward placed in series, so that the heater serves as a resistance to limit the current taken. The heater may be placed within a tubular incandescent body or may itself be luminous; it may be a carbon filament, the lamp being fitted with a closed bulb, which is either exhausted or contains an inert gas. The change of connections may be effected by a hand or automatic switch. Two or more incandescent bodies may be arranged in one lamp for use simultaneously or successively. In one arrangement described, two incandescent rods are surrounded by heating coils operating independently; at the middle of the lamp one end of each rod is permanently joined to a supply wire, and one end of each heater to the other supply terminal; the other ends of the rods and heaters are connected with coiled springs, which, when cold, touch contacts connected with the supply terminals, so that the rods and heaters are connected in parallel, but when the springs are heated they touch one another and connect the outer ends of the rod and heater at each side of the lamp, so that these are then in series.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

IMPORTANT RULING IN NEW TELEPHONE CASE—Judge S. R. Artman on the afternoon of December 19, at Lebanon, Ind., rendered an important decision in a case involving the rights of telephone and electric railway companies. The new Long-Distance Telephone Company, of Indianapolis, was plaintiff in a suit against Townsend, Reed & Company, builders of the Northwestern Traction line, and asked that the latter be enjoined from interfering with its wires. The Court rendered a finding for the defendants. Judge Artman held that, where a traction company has to string its trolley wires in a certain way, telephone companies are required to change their wires to conform thereto. A telephone company can not enjoin a traction company from thus interfering with its wires, but it may recover from the traction company by a suit at law, the expenses incurred by the enforced change of wires to conform with those of the electric line. The plaintiff has appealed the case to the Supreme Court.

KANSAS CITY RAILWAY COMPANY VOTES FOR EXTENSIVE IMPROVEMENTS—The directors of the Kansas City Railway and Light Company, at a meeting on December 18, voted $1,000,000, to be applied upon improvements now under way by the Metropolitan Street Railway Company. The directors also decided to begin in January the publication of a monthly statement of the company's earnings. This will show the earnings of both the Metropolitan and the Kansas Electric Light Company, which are controlled by the Kansas City Railway and Light Company. It is stated that very much better service will be had very soon. The new power-house is sufficiently large to accommodate machinery to operate a street car line and light a city of one and one-quarter million people. It is expected that operations will begin somewhere between January 15 and February 1. The ultimate capacity of the power plant will be some 40,000 kilowatts. The directors also authorized the purchase of about forty new cars for summer use. The following directors attended the meeting: P. A. Valentine, Chicago, Ill.; Louis C. Krauthoff, C. L. Blair and John B. Dennis, of New York; Bernard Corrigan, H. C. Flower, J. F. Downing, Stuart R. Knott, E. F. Swinney, L. E. James, Hugh C. Ward, J. J. Heim and P. E. Chappel, of Kansas City.

PERSONAL MENTION.

MR. J. E. ANDERSON has been appointed master mechanic of the Mexican International Railroad Company, with offices at Monclova, Mexico.

MR. S. K. SMITH, C. E., until recently chief engineer of the Northern Pacific Coal Company, is now county surveyor of Yellowstone County, Montana.

MAJOR WILLARD L. CANDEE, manager of the Okonite Company, New York city, arrived home on the Cedric from an extended trip abroad, in time for the Christmas festivities.

MR. GEORGE ST. PIERRE has been appointed to succeed the late Mr. George W. Spink as master mechanic of the Oakland Transit Consolidated and of the San Francisco, Oakland & San Jose Railway Company, Oakland, Cal.

MR. WILLIAM LUX, until recently employed on the engineering staff of the Lackawanna Iron and Steel Company, Lebanon, Pa., has accepted a position as a civil engineer with the Brooklyn Heights Railway Company, Brooklyn, N. Y.

MR. DANIEL WILLARD, first vice-president and general manager of the Erie Railroad Company, was recently elected second vice-president of the Chicago, Burlington & Quincy Railroad Company, with headquarters at Chicago.

MR. T. F. MANVILLE, president of the H. W. Johns-Manville Company, 100 William street, New York city, started for the West on December 22. Before returning, Mr. Manville intends visiting the company's Milwaukee, Chicago, St. Louis and New Orleans branches.

MR. ARCHIE MACNANEMY, formerly chief mechanical and electrical engineer of the Cleveland-Southwestern Traction Company, has been appointed to the same position with the Indianapolis, Columbus & Southern Railroad Company, with headquarters at Greenwood, Ind.

M. EMILE GUARINI has published in pamphlet form a French translation of a series of articles on "Electricity in European Mines," which appeared in the *Engineering Magazine*. The pamphlet is well illustrated, and gives a complete review of the use of electricity for this purpose.

MR. J. L. GREATSINGER, ex-president of the Brooklyn Rapid Transit Company, Brooklyn, N. Y.; Mr. Peter Kimberly, Sharon, Pa., and associates have proved up a valuable copper mine in the wilderness sixty-five miles west of Port Arthur, Ontario, and fourteen miles south of the Canadian Northern road.

MR. L. E. WOGLEMUTH, heretofore chief draughtsman of the Chicago, St. Paul, Minneapolis & Omaha Railway Company, has been appointed mechanical engineer of the company, with offices at St. Paul, Minn., to succeed Mr. B. R. Moore, who has been appointed assistant superintendent of motive power and machinery, with headquarters at Sioux City, Iowa, succeeding Mr. F. M. Dean.

MR. JOHN B. ALLAN, who was recently elected a vice-president and the general manager of the Allis-Chalmers Company, was born January 14, 1860, in Davenport, Iowa, where he received a grammar and high school education. He afterward graduated from the Worcester Polytechnic Institute, at Worcester, Mass., graduating as a mechanical engineer. In his new position, Mr. Allan has general charge of manufacturing, selling and general operations under the president.

MR. PETER COOPER HEWITT has become an accepted entrant for the preliminary trials and inspection of cars, looking to a contest for the Gordon Bennett cup, under the auspices of the German Automobile Club, of Berlin, Germany. Preliminary trials and inspection of cars will be held at some date between April 15 and May 15, depending upon the date set for the race in Germany, and it is expected that competitors will have at least six weeks time between the date of trials and the date of race. Other entrants for this race are Alden Sampson, 2d, and L. H. Kittridge.

MR. J. C. BRACKENRIDGE, who has for several years past acted as chief engineer of the Brooklyn Rapid Transit Company, will resign that position to accept that of Brooklyn Commissioner of Public Works, under the incoming administration. It is believed that the vacancy thus caused will remain unfilled, but that Mr. H. S. Wilgus, Mr. Brackenridge's principal assistant, will be appointed engineer in charge. Mr. Wilgus was formerly connected with the Pennsylvania Railroad, and is a brother of Mr. W. J. Wilgus, fourth vice-president of the New York Central & Hudson River Railroad Company.

DR. CLAYTON H. SHARP, engineer of the electrical testing laboratories of the Lamp Testing Bureau, New York city, returned on Monday, December 21, from a trip to Europe, during which he visited all of the principal electrical laboratories abroad. Dr. Sharp has gathered a mass of data and information which will enable him to fit up the new laboratories of the company, at Eightieth street and East End avenue, New York city, with the most complete and up-to-date apparatus, and by the best methods known. Dr. Sharp carried with him a number of carefully prepared standard photometer lamps, which were compared by the principal photometrists of Europe, with their authorized standards, and they were found to be in extremely close agreement with the best of them. The company will probably occupy its new laboratories early in 1904.

ELECTRIC LIGHTING.

ST. PAUL, MINN.—It is stated that an electric light plant is to be established at Minot.

BROCKVILLE, ONT.—The town light commissioners have asked the council to expend $25,000 on the electric light plant here.

BLOOMINGTON, ILL.—The Weldon city council has completed the purchase of the electric light and water plant of that village.

YREKA, CAL.—A five-year street lighting contract has been awarded to the Yreka Electric Light Company by the city trustees.

ALLENTOWN, PA.—The United Gas Improvement Company has purchased the gas and electric plants at Watkins, N. Y., and Somerville, N. J.

WARREN, OHIO—The Geneva Electric Illuminating Company has increased its capital stock from $1,000 to $100,000, to pay for improvements.

HELENA, MONT.—It is stated that a movement is on foot to install an electric light plant in East Helena, to be operated and owned by the city.

NORTHAMPTON, MASS.—The city council has awarded a three-year contract to the Northampton Electric Lighting Company for lighting the public buildings.

CINCINNATI, OHIO—D. J. Long, of Mechanicsburg, has been granted a franchise for twenty-five years by the village council, to operate an electric plant there.

ATHENS, GA.—The new electric power plant at Tallahassee Shoals has been completed, and is now furnishing over 1,000 horse-power to various manufactories.

TUNKHANNOCK, PA.—The work of excavating for the Wyalusing Electric Light, Heat and Power Company has been commenced, and construction will be pushed rapidly.

BELFAST, ME.—The Belfast Gas and Electric Company intends to utilize Hiramdale falls on Goose river for additional power, which will allow of a continuous service.

NEWPORT NEWS, VA.—The city council has passed an ordinance asking the legislature to authorize a $100,000 bond issue for the purpose of establishing a municipal electric plant.

HANCOCK, MICH.—The Hancock city council has awarded a three-year contract for street lighting to the Houghton County Electric Light Company, at the rate of $86 per lamp per year.

WICHITA FALLS, TEX.—Galveston parties have secured a franchise from the city to erect and maintain an electric light and power plant. It is understood that the new system will give night and day service.

DOWNEY, CAL.—Work will begin in a short time on the new electric light plant, which will be erected by local capitalists. Among those interested are A. L. Ball, T. R. Crawford, Joseph Smith and S. S. Skidmore.

PHILADELPHIA, PA.—The township committee at May's Landing, N. J., has awarded the contract to light the thoroughfares of the town to the International Heat, Light and Power Company, of Philadelphia, for one year.

COLUMBUS, IND.—Wayne Township, Bartholomew County, has voted a $26,000 two per cent tax to aid the Central Indiana Traction Company, which proposes to build an interurban railway from Columbus to French Lick.

OWENSBORO, KY.—The report of the manager of the city electric plant for the year ended November 30 shows that the income for the year was $34,810.32, and the operating expenses $33,318.69, leaving a balance of $491.63.

AUBURN, N. Y.—The Auburn Light, Heat and Power Company has been awarded a two-year contract by the supervisors. The price is not to exceed $1,388 a year, which is stated to be a large reduction over the price previously paid.

LEXINGTON, KY.—There is a move on foot to extend the Lexington-Paris traction line to Maysville, Carlisle, Blue Licks, Oakwood, Ewing and Flemingsburg. William Watson, a capitalist of Ashland, Ky., is said to be interested.

WICHITA, KAN.—W. H. Whitted, of Denver, has bought the Salina gas and electric plant from W. C. Hook, of Leavenworth. Mr. Whitted, backed by Denver capitalists, will rebuild the plant and put in operation an electric street railway.

BALTIMORE, MD.—The company which was recently organized by James E. Ellwood and others, for the erection of an electric light plant at Salisbury, Md., will be known as the Salisbury Electric Light Company. The erection of the plant will be begun as soon as possible.

WALLACE, IDA.—The electricians of the Washington Water Power Company, of Spokane, have about completed the company's installation for the present. The company is now delivering 1,600 horse-power to the various mines, but it is intended to double the output during the coming year.

ITHACA, N. Y.—Articles of incorporation have been filed by the Ulysses Electric Light and Power Company, to operate in and around the village of Trumansburg. The capital stock is $23,000, and the directors are Frank C. Biggs and Ossian G. Noble, of Trumansburg, and Gardner S. Williams, of Cornell University, Ithaca.

DENVER, COL.—Amended articles of incorporation have been filed by the New Century Light and Power Company, showing that at the annual meeting it was voted to change the par value of each share of stock from $100 to $1, and divide the capital stock into 4,000,000 shares, 2,000,000 of which will be preferred and 2,000,000 common.

NIAGARA FALLS, N. Y.—D. W. Allen, of Buffalo; E. A. C. Pew and A. Nelson, of Toronto; J. H. Teare, of Algoma, Ontario, and Darcy Scott, of Ottawa, have incorporated the Erie & Ontario Development Company. They propose to develop electrical power from the fifteen and sixteen-mile creeks which empty into Lake Ontario. The company is capitalized at $96,000.

PLAINFIELD, IND.—The Public Service Company has been organized to furnish Plainfield with electric lights and power for machinery, etc. The company has a capital of $50,000, and the officers are: president, W. B. Vestal; treasurer, Sanders Hubbard; secretary, Benjamin Hubbard. Work is to begin immediately, and it is hoped to have it completed by May 1.

BANGOR, PA.—At a special meeting of the Bangor Electric Light, Heat and Power Company, B. F. Dilliard, Milford Bray, George Rasely and John I. Miller were elected directors to serve in place of Thomas Masters, Milton Flory, William Bowers and Thomas Ditchett. William Bray was elected president to fill the unexpired term of Thomas Ditchett, and Milford Bray, treasurer, in place of William Bray.

WILKESBARRE, PA.—The Wyoming Valley Electric Light, Heat and Power Company has reelected the following: Abram Nesbitt, president; Charles W. Lee, vice-president; E. W. Mulligan, secretary and treasurer; John Flanigan, general manager. Directors, the above and J. W. Hollenback, E. H. Jones, I. A. Stearns, A. A. Sterling and Liddon Flick.

NASHVILLE, TENN.—The actual work of constructing the interurban line connecting Gallatin, Nashville and Columbia has been begun. The preliminary survey was made some time back and rights of way secured. The two companies originally organized were recently consolidated under the name of the Nashville, Columbia & Gallatin Electric Railway and the capital stock increased to $3,000,000.

CAMDEN, N. Y.—The electric light commission, which was appointed last April by the village board, in accordance with the result of the vote taken at a special election, has filed its report with the board of trustees. The committee is unanimously in favor of the establishing of a plant, and favors the establishment of a water power plant on Fish creek, about one and one-half miles from the village.

DOVER, N. H.—The stockholders of the United Gas and Electric Company at their annual meeting elected the following directors: George E. Wallace and Albert Wallace, of Rochester; J. Frank Lang, Portland, Me.; Herbert L. Shepard, Rockland, Me.; John Kivel, of Dover; George E. Macomber, Augusta, Me. The directors organized as follows: president, Albert Wallace, Rochester; clerk, Leslie P. Snow, Rochester; treasurer, George G. Walch, Dover; general manager, Thomas Hawkins, Rockland, Me.; general auditor, J. Frank Lang, Portland, Me.

TELEPHONE AND TELEGRAPH.

DOWS, IOWA—The James Telephone Company will build a line east from here.

BLOOMFIELD, IOWA—The Citizens' Mutual Telephone Company has been incorporated.

SEDAN, IOWA—A telephone line is projected to run from Chariton, Mo., to this place.

PALMER, IOWA—Rural telephone lines are said to be projected to Pocahontas and to Pomeroy.

PITTSBURG, PA.—The Bell Telephone Company is extending its lines from Wilmerding to Walls.

SHEFFIELD, IOWA—The People's Mutual Telephone Company has been granted a local franchise.

DES MOINES, IOWA—The Iowa Telephone Company will extend its local system and make repairs.

DETROIT, MICH.—The Michigan Telephone Company will install an exchange in the village of Tekonsha.

CHICAGO, ILL.—The Automatic Telephone Company will increase its capital from $3,000,000 to $5,000,000.

GREENFIELD, IND.—The S. Morrison Company is extending its lines to Fortville, Pendleton and Knightstown.

LORRAINE, N. Y.—The Black River Telephone Company is placing a number of telephones in the village.

AMSTERDAM, N. Y.—The Home Telephone Company, of Schenectady, is now connected with the Automatic Telephone Company, of Amsterdam.

LITTLE ROCK, ARK.—The Russellville Telephone Company has been incorporated with a capital of $10,000, by R. M. Drummond, W. Rowan, A. Bernard and R. C. Brown.

HARTLAND, VT.—W. R. Sturtevant has sold his interest in the local telephone line to E. A. English, and the plant will be run under the name of the Hartland Telephone Company.

MADISON, WIS.—The Readstown Telephone Company, of Readstown, Vernon County, has been incorporated with a capital of $5,000. The incorporators are F. M. Groves, G. W. Heinke and C. W. Reeve.

BINGHAMTON, N. Y.—The Riverside Telephone Company now has lines connecting Bainbridge with all the towns between there and Binghamton. A line to Wellsbridge has also been put in operation.

PAULSBORO, N. J.—The telephone service of this place has been very much improved, three new trunk lines having been constructed, one to Gibbstown and Pennsgrove, one to Woodbury, and one direct to Philadelphia.

GADSDEN, ALA.—The city of Attalla has sold to the Southern Bell Telephone Company its exchange in that city. The transaction also carries with it a franchise for the Southern company to do business in Attalla.

WICHITA, KAN.—The Missouri & Kansas Telephone Company has secured a franchise from the town of Mount Hope for the establishment of a telephone exchange. The company has also located an exchange at Sedgwick.

DES MOINES, IOWA—George N. Bandy, of this city, is one of the chief organizers of the Hanamo Telephone and Telegraph Company, organized in Delaware with a capital of $1,000,000. The plans of the company are to absorb a large number of the mutual and rural lines in southern Iowa and northern Missouri. Its headquarters will be in this city.

LITTLE ROCK, ARK.—The North Arkansas, South Missouri & Indian Territory Telephone Company has been organized, with the following officers: president, W. T. Stahl, Siloam Springs; vice-president, W. T. McCormick, Prairie Grove; secretary, K. G. Comfort, Westville, I. T.; treasurer, H. O. Beeson, Pineville, Mo. The system will embrace 1,100 miles of lines.

CHICAGO, ILL.—The Citizens' Telephone and Telegraph Company, of Evanston, which has applied for a franchise, will, it is said, connect with the Illinois Telephone and Telegraph Company. The incorporators of the company are James E. Keelyn, W. S. Mason, Schuyler J. Stratton, C. A. Wightman, B. B. Noyes, W. J. O'Connell and Thomas E. Connor, and the capital is $150,000.

GRAND RAPIDS, MICH.—The Citizens' Telephone Company has opened its new line between Grand Rapids and Benton Harbor, a portion of the proposed line from Grand Rapids to Chicago. The whole line, it is expected, will be completed by spring. When it is finished, the local exchange will be connected with the Chicago exchange of the Illinois Telephone and Telegraph Company.

READING, PA.—The Consolidated Telephone Company announces that it will extend its lines so as to connect Pleasantville and Boyertown, taking in Shanesville and Gablesville. The company will then build lines from Boyertown to Pottstown and Bally, and from Kutztown to Kempton and Lenhartsville, and Womelsdorf will be placed in touch with the Reading exchange in the near future.

PONTIAC, MICH.—A line from Sand Hill to a point on the Franklin road has been completed by the Cooperative Telephone, of Detroit, and the subscribers of the Oakland Telephone Company throughout the country now have connection with Detroit. By connection with the Alma Telephone Company, the Oakland company also reaches many of the independent exchanges of the state, so that Pontiac now has independent telephone connection with the greater part of Michigan.

HARTFORD, S. D.—The managers of the Union Telephone Company, which was recently organized here, are pushing the work of constructing several rural routes, which will centre here. The company has made arrangements to connect with the local and long-distance lines at this place, but has abandoned the idea of wiring the town. At a meeting of the stockholders of the company, the following officers were elected: president, Martin McLeod; vice-president, F. E. Van Demark; secretary and superintendent, D. W. Greatorex; treasurer, E. W. Manson.

KALAMAZOO, MICH.—The new Citizens' Telephone Company, whose system is expected to be in operation within a few months, has organized with the following officers: president, F. F. Rowe; vice-president, W. W. Olin; secretary and general manager, R. C. Packard, Toledo; treasurer, E. W. Bowman. The company is capitalized at $250,000, and it is claimed that the project will be backed by eastern capital. Work is to commence immediately, and at the start exchanges will be opened at Galesburg, Augusta and Richland. Toll lines will be run in from all the rural districts to connect with the various exchanges. Construction within the city limits of Kalamazoo will begin next spring.

BEAVER, PA.—A charter has been recorded here incorporating the Beaver Valley Telephone Company, with the following directors: John M. Buchanan, Agnew Hice and Robert W. Darragh, of Beaver; John H. Miller, James G. Mitchell and Henry M. Camp, of Rochester; John Reeves, J. S. Louthan and Frank F. Brierly, of Beaver Falls; F. G. Barker, F. W. Walker, J. F. Mitchell and R. D. Hunter, of New Brighton; Edward J. Bischoffberger, of Freedom, and Paulus E. Koehler, of Monaca. The line will connect the following towns: Eastvale, Beaver Falls, Patterson Heights, College Hill, Homewood, Ellwood City, Rock Point, Bridgewater, Beaver, Vanport, Industry, Smiths Ferry, Georgetown, Hookstown, Rochester, Monaca, Freedom, Baden, Economy and Ambridge. The capital stock is $100,000.

BALTIMORE, MD.—The Maryland Telephone and Telegraph Company has opened a long-distance line from Baltimore to Hagerstown, through connection with the Frederick Telephone and Telegraph Company and the United Telephone Company, of Hagerstown. This connection opens up a service to points in Washington County, through the Cumberland valley, in Pennsylvania, to Waynesboro, Chambersburg, Shippensburg and other places, and to many points in Virginia and West Virginia, including Winchester, Berryville, Front Royal, Martinsburg, Shepherdstown, Berkeley Springs and Charlestown. The company states that it is its intention to ultimately have the service extended to Pittsburg. To do this it will only be necessary to extend the present line from Berkeley Springs, W. Va., to Cumberland, Md., as the Johnstown (Pa.) Telephone Company is now building a line down to Cumberland, and it has a service to Pittsburg through a connection with the Pittsburg & Allegheny Telephone and Telegraph Company. The Chesapeake & Potomac Telephone Company will open two new exchange branches in Baltimore within a short time, and this will necessitate the rearrangement of the lines of many subscribers. The company is now operating in Baltimore about 15,000 telephones.

NEW INCORPORATIONS.

MEROM, IND.—Merom Telephone Company. $10,000.

COURTLAND, KAN.—Courtland Telephone Company. $2,500.

DUBUQUE, IOWA—The Midland Railway Company, $250,000.

TOPEKA, KAN.—Republic City Telephone Company. $2,500.

DES MOINES, IOWA—Graettinger Telephone Company. $10,000.

ALTOONA, PA.—Coalport Light, Heat and Power Company. $5,000.

PHILADELPHIA, PA.—The General Lighting Supply Company. $35,000.

COALPORT, PA.—Coalport Light, Heat and Power Company. $5,000.

WASHINGTON, PA.—Chartiers Valley Traction Company. $10,000.

PHILADELPHIA, PA.—The Eastern Electric Company. $100,000.

HARRISBURG, PA.—The Ellwood City Electric Street Railway Company. $9,000.

PHILADELPHIA, PA.—Giant Electric Light, Heat and Power Company, $10,000.

CLEVELAND, OHIO—Ohio Valley Telephone and Telegraph Company. $20,000.

NASHVILLE, TENN.—Citizens' Telephone Company. Increased from $7,000 to $12,000.

NASHVILLE, TENN.—Stantonville Telephone Company. Increased from $3,000 to $10,000.

JERSEY CITY, N. J.—The Interurban Traction Company. Reduced from $1,000,000 to $125,000.

INDIANAPOLIS, IND.—The Wabash & Rochester Railway. Increased from $100,000 to $950,000.

NORTHUMBERLAND, PA.—Northumberland Electric Light, Heat and Power Company. $5,000.

ALBANY, N. Y.—The Central Long Island Electric Light Company. Increased from $5,000 to $500,000.

KITTERY, ME.—Monarch Railway Company. $2,000,000. Incorporators: E. L. Chaney and F. J. Sutton.

PORTLAND, ORE.—Postal Telegraph Cable Company. $10,000. Incorporators: J. Annand, B. S. Durkee, R. L. Brackett.

GIBSON CITY, ILL.—Gibson Home Telephone Company. $25,000. Incorporators: A. L. Phillips, B. G. Schlosser, H. A. Ball.

UTICA, N. Y.—Kirkland Electric Company. $100,000. Incorporators: James F. Wood, George L. Wood and Horace B. Sovert.

CHICAGO, ILL.—Union Water, Light and Traction Company, $50,000. Incorporators: Owen Ford, G. M. Gore and B. V. Beekman.

WATERTOWN, WIS.—The Rock River Traction Company. $5,000. Incorporators: P. L. Utley, Henry Mulberger and W. H. Woodard.

MINNEAPOLIS, MINN.—McClure Lighting Company. $10,000. Incorporators: Franklyn D. Clark, Edward Stump and W. M. Brugger.

CAMDEN, N. J.—Improvement Lighting Company. $100,000. Incorporators: Samuel F. Wheeler, H. Franklin Brossman and C. Meeteer.

COLUMBUS, OHIO—The Dayton & Germantown Traction Company. Changed to the Dayton, Germantown & Middletown Traction Company.

JERSEYVILLE, ILL.—Union Water, Light and Traction Company. $50,000. Incorporators: Owen Ford, G. M. Gore and B. V. Beekman.

AUSTIN, TEX.—Smithville Telephone Company. $10,000. Incorporators: W. R. Searcy, Y. Hill, J. M. More, R. Bryne and J. H. Chancellor.

JERSEY CITY, N. J.—Atlantic County Electric Company, $30,000. Incorporators: Robert Ohmniess, Thomas T. Mather and A. M. Worstall.

EAST ORANGE, N. J.—Reinhardt Light Company. $300,000. Incorporators: Leonard J. Reinhardt, Charles L. Bush, Clarence L. Edmonston.

RALEIGH, N. C.—The Cliffdale Telephone Company. $5,000. Incorporators: J. A. Calton, Edward Thompson and G. W. Long, all of Cliffdale.

ALBANY, N. Y.—Interstate and Marine Telegraph Company, $10,000. Directors: Thomas J. Ryan, E. Hanssner and F. E. Sharot, of New York city.

FORT COLLINS, COL.—New Power Company. $100,000. Incorporators: William F. Garbe, Albert Damm and Albert Z. Magede, Fort Collins.

NASHVILLE, TENN.—The Roaring Fork Telephone Company. $250. Incorporators: C. Hardin, J. N. Holbrook, H. Carter, F. F. Hardin and J. K. Hardin.

LITTLE ROCK, ARK.—The Malvern City Telephone Company. $8,000. Incorporators: W. H. Cooper, L. Myers, A. M. Duffield, J. M. Williams and D. C. Butler.

LOS ANGELES, CAL.—Allied Electric Corporation. $1,000,000. Directors: M. V. McQuigg, C. W. Allen, R. C. P. Smith, K. R. Smith and J. M. Gardiner.

BANGOR, ME.—The Bangor Automatic Telephone Company. $250,000. President, C. F. Bragg; vice-president, A. A. White; treasurer, J. A. Boardman.

MADISON, WIS.—The Watertown & Oconomowoc Light, Heat and Power Company. $5,000. Incorporators: W. C. Stone, A. E. Smith and Paul D. Durant.

BRUSHTON, N. Y.—The Brushton Electric Light Company. $6,500. Directors: R. E. Hiffeman, G. Walter Galsey and W. H. McCarthy, of Brasher Falls.

GUTHRIE, OKLA.—The Shawnee Traction Company. $300,000. Incorporators: H. G. Beard, C. E. Jackson, J. W. Aydelotte, of Shawnee, and J. J. Henry and D. J. McCanne, of Denver, Col.

ALBANY, N. Y.—Bruckner Telephone and Electric Company. $15,000. Directors: F. C. Bruckner and St. C. B. Gwynn, New York, and A. E. Hoecker, Brooklyn.

HILLSBOROUGH, N. J.—The Hillsborough & Montgomery Telephone Company. $125,000. Incorporators: Peter A. Garretson, William C. Hendrickson, William M. Frankhouser, Louis E. Opie, A. J. Van Nuns, B. Meade, David J. Smith and Jacob C. Gulick.

GRASS VALLEY, ORE.—Grass Valley Electric Light, Water and Power Company. $5,000. Incorporators: W. F. Weigand, C. W. Moore, J. D. Wilcox, J. H. Rinearson, E. Hannah.

AUGUSTA, ME.—Eastern Traction Company. $180,000. Directors: F. G. Martin, F. L. Dow, C. W. Mullen, H. F. Bailey, E. B. Weeks and W. H. Waterhouse.

CLEVELAND, OHIO—Cleveland, Chardon & Meadville Railway Company. $5,000. Incorporators: W. C. Warner, Monroe Warner, A. R. Warner and H. A. Stahl.

FRANKFORT, KY.—Hopkinsville Home Telephone Company. $100,000. Incorporators: A. W. Hoge and Gustav Hirsh, of Lima, Ohio, and E. B. Tyler, of Hopkinsville.

SPRINGFIELD, ILL.—Illinois Central Traction Company. $100,000. Incorporators: W. B. McKinley, Charles Reilly, B. R. Stephens, F. H. Hahn, H. J. Pepper, Champaign, Ill. To construct an electric line from Decatur to Springfield.

ALBANY, N. Y.—The Schenectady, Delanson & Esperance Telephone Company. $1,500. Directors: Jacob V. Widder, of South Schenectady; L. L. Tepering, of Delanson; William Tiffany, Burt Grantier and Eugene Grantier, of Esperance; Clarence A. Culding, of Mariaville, and Frank McMillan, of Duanesburg.

HARRISBURG, PA.—The Trenton, New Hope & Lambertville Street Railway Company. $100,000. To build a road twelve miles long, from Yardley, Bucks County, to the borough of New Hope, thence to the approach of the bridge over the Delaware connecting New Hope with Lambertville, N. J. President, T. Sidney Cadwallader, Yardley, Pa.

ELECTRIC RAILWAYS.

ITHACA, N. Y.—A trolley road is about to be built from Oneonta, *via* Davenport, Stamford, Grand Gorge and Windham, to Catskill.

ALBANY, N. Y.—The state board of railroad commissioners has authorized the construction of an electric railroad between Ithaca and Cortland, a distance of twenty miles, by the Ithaca-Cortland Traction Company.

DAVENPORT, IOWA—A total reorganization of the Citizens' Railway and Light Company has been effected at Muscatine. The following officers were elected: president, William Musser; vice-president, J. R. Swearengen; secretary-treasurer, H. W. Huttig.

HOUSTON, TEX.—The city council of Houston has granted a franchise for an interurban line over its streets, and it is announced that the promoters will begin work at once on the road. It is proposed to build an air line to Galveston, a distance of forty-eight miles, and the right of way has been secured for the project.

LEXINGTON, TENN.—Farmers and local capitalists are at work looking to the organization of a company to build an electric line from Huntingdon to Milan or Trenton, using abandoned right of way of the railroad that was graded some years ago through McLemoresville. A company is to be organized and the project carried out before next fall.

AUGUSTA, ME.—The railroad commission has approved a petition of the Kingfield & Dead River Railway Company for extension from Carrabasset, through Dead River plantation, to Flagstaff, about twelve miles. The extension, to be known as the Moosehead Railroad, will reduce the distance to Portland by twelve miles and to Lewiston by twenty miles.

GRAND RAPIDS, MICH.—At a meeting of the East Grand Rapids village board the Grand Rapids & Ionia Electric Railway Company was granted a franchise through the village and along certain streets, provided that work shall commence within the next eighteen months and that the line shall be completed and in operation within thirty months.

TRENTON, N. J.—That it may complete its proposed connection with the Trenton & New Brunswick Fast Line Company, the Camden & Trenton Trolley Company has instituted condemnation proceedings to gain the required right of way. It is announced that the connection will be made in less than a month after possession of the needed land is secured. This will mean a continuous trolley line from Camden to Jersey City.

JEFFERSON, MO.—The Joplin, Neosho & Peirce City Interurban Railway Company has been chartered to build an electric line in southwest Missouri in the counties of Jasper, Lawrence, Newton and Barry, and to run through Joplin, Sarcoxie, Peirce City, State City, Newtonia, Granby and Neosho. The line is to be about fifty miles in length, and the company has a capital of $50,000. The incorporators are Charles Cunliff, William S. Brawner, John Kimpel, John Weathers and Benjamin Cunliff, all of St. Louis.

MEMPHIS, TENN.—A movement has been set on foot for the building of a line of railway from Birmingham, Ala., to Lineville, in the eastern part of that state. A company has been organized with a capital stock of $100,000. The road is to run through Jefferson, Shelby, St. Clair and Talladega counties to Clay County, and is to be known as the Birmingham & Lineville Railroad. It will reach Pyriton, in Clay County, which is the centre of a rich mineral region. The road will be about one hundred miles in length and will penetrate a new and undeveloped mineral, agricultural and timber region. R. H. Pearson is president; John S. Jemison, vice-president, and R. L. Ivey, treasurer.

BROWNSVILLE, TENN.—The Shelby County Traction Company, which proposes to construct and operate an interurban electric line between Memphis and Collierville, has received a proposition from large property holders of Dyer, Crockett and Haywood counties to build from Brownsville to Dyersburg. It is proposed for this Brownsville-Dyersburg line to pass through Alamo, the county seat of Crockett County. Thus it will connect the county seats of the three counties through which it will pass. The proposed route is north from Brownsville to Alamo, and then northwest along the general course of the Middle Fork of the Forked Deer river to Dyersburg. There are a number of good interior towns on the route.

ELECTRICAL SECURITIES.

Last week was considerably shortened in very nearly all financial centres of the world, by reason of the Christmas holidays. Notwithstanding the short period of business, a great deal of speculative confidence was developed, and the financial community is hoping for a good January boom. The notable improvement of the stock market in the past two months has strengthened this hope, and the present market outlook has a tendency to make an optimistic feeling predominant. The recent apprehension of serious disturbances in the far east has been the means of unsettling many convictions in foreign securities, resulting in the disposal of these in the American markets. At the present time, however, there is every indication that a settlement will be reached without resorting to arms. The beginning of the new year promises that, with the large orders in hand and the positive revival of trade which a peaceful passing of eastern crises would bring, prices will go higher as the increased demand comes on.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 26.

New York:	*Closing.*
Brooklyn Rapid Transit	53⅛
Consolidated Gas	195
General Electric	171
Kings County Electric	178
Manhattan Elevated	143⅝
Metropolitan Street Railway	123
New York & New Jersey Telephone	145
Westinghouse Manufacturing Company	195

A quarterly dividend of 2½ per cent upon the preferred and the assenting and non-assenting stocks of the Westinghouse Electric and Manufacturing Company will be paid January 11, 1904, to stockholders of record at the close of business December 31. Transfer books will close December 31, 1903, at 3 o'clock P. M., and reopen on January 12, 1904, at 10 o'clock A. M.

Boston:	*Closing.*
American Telephone and Telegraph	127
Edison Electric Illuminating	224
Massachusetts Electric	75¾
New England Telephone	122
Western Telephone and Telegraph preferred	81

Philadelphia:	*Closing.*
Electric Company of America	8
Electric Storage Battery common	53
Electric Storage Battery preferred	53
Philadelphia Electric	5¾
Union Traction	45⅜
United Gas Improvement	84

Chicago:	*Closing.*
Chicago Telephone	122
Chicago Edison	145
Metropolitan Elevated preferred	54
National Carbon common	21½
National Carbon preferred	90
Union Traction	5¾
Union Traction preferred	25½

The directors of the Chicago Edison Company will meet about January 15 to act on the regular quarterly dividend of 2 per cent, payable in February.

It is stated that at the annual meeting of the South Side Elevated, to be held January 28, the matter of an additional issue of stock will be considered. The new issue will probably amount to $5,000,000 or $7,000,000. At the end of its fiscal year, December 31, the company possesses a surplus of $1,000,000.

AUTOMOBILE NOTE.

COMMERCIAL VEHICLE CONTEST—The Automobile Club of America, New York city, N. Y., announces that on March 15 and 16, 1904, the contest committee of the club will hold a contest for commercial vehicles of the light and heavy types. Rules and further particulars will be announced later.

INDUSTRIAL ITEMS.

THE ASHTON VALVE COMPANY, Boston, Mass., manufacturer of Ashton "pop" valves and gauges, is sending out its annual calendar.

WALTER E. SCOFIELD, manufacturing agent, New York city, is sending out a leaflet illustrative and descriptive of the Hughes adjustable telephone bracket. This leaflet will be sent on request.

THE W. S. HILL ELECTRIC COMPANY, New Bedford, Mass., is sending out copies of its bulletin No. 123 and index of the company's approved list of bulletins. Bulletin and index will be sent on request.

THE JEFFERY MANUFACTURING COMPANY, Columbus, Ohio, is sending out an attractive catalogue illustrative and descriptive of "Jeffery screens." This catalogue contains numerous testimonials and will be sent on request.

THE ROYAL ELECTRIC COMPANY, Peoria, Ill., manufacturer of alternators and transformers, is distributing a useful calendar for 1904. The illustration is of a 100-kilowatt, sixty-cycle, Royal alternator, of the inductor type.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, is distributing its calendar for 1904. It is safe to say that wherever this calendar is placed, it will never be overlooked. The figures are very large and distinct, and can be seen at a considerable distance.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., reports a gratifying appreciation of the Junior midget plug and receptacle, which it has just put out. The price of these plugs is considerably lower than usual, and they can be used in all places, except floors, where temporary connections for light current are required.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., in bulletin No. 137 describes and illustrates the "voltaphone." This new instrument is a combination of three important factors in the production and distribution of electrical energy —the voltmeter, the telephone and the clock.

THE NEWTON MACHINE TOOL WORKS, Philadelphia, Pa., in catalogue No. 37 describes and illustrates a line of rotary planers. These are built in eleven sizes, with heads from fourteen inches to eighty-four inches in diameter over tools. The machines are built either fixed, portable or on a round base, and either belt or motor-driven. This bulletin will be sent upon request.

THE O. J. MULFORD ADVERTISING COMPANY, Detroit, Mich., is distributing a handsome booklet descriptive of its service for magazine, newspaper and street car publicity. A series of excellent half-tone engravings, depicting the office appointments of the Mulford company, is given, and the letter text tells of the methods and operations. This pamphlet will be sent upon request.

THE DOWNWARD LIGHT ELECTRIC COMPANY, of New York, has opened a western office in the Ellsworth Building, 353-357 Dearborn street, Chicago, Ill. Mr. A. W. Wicks will be in charge of this office. Mr. Wicks was for a number of years connected with the contracting department of the Chicago Edison Company, and is very pleasantly known throughout electrical circles of the West, especially.

THE PITTSBURG TRANSFORMER COMPANY, Pittsburg, Pa., will be pleased to send an attractive card calendar for January, 1904, to its patrons. The company is also sending out a leaflet illustrating transformers for lighting and for power transmission. These are in fifty-kilowatt, 1,100 and 2,200-volt primary, 110 and 220-volt secondary, oil-cooled types, and 150-kilowatt, 10,000-volt, oil-insulated, self-cooled types.

THE CENTRAL TELEPHONE AND ELECTRIC COMPANY, 909 Market street, St. Louis, Mo., will be pleased to send its catalogue No. 18 to any one interested. This describes and illustrates telephone instruments and switchboards. In addition to the complete listing and description of telephone apparatus manufactured by this company, there is shown a series of the exhibition buildings of the St. Louis Exposition. This is a valuable souvenir, and will, no doubt, be greatly appreciated by all who receive it.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., reports a gratifying business for the outgoing year of 1903 and states that 1904 will witness still further improvement and development of this business. The company states that it will continue to push the same specialties with which its name is already so well identified—*viz.*, "Okonite," and "I. X. L." wires, "D & W" enclosed fuses and safety devices, "Pittsburgh" transformers, and "Columbia" lamps.

F. B. BADT & COMPANY, 1504 Monadnock Block, Chicago, western agents for the Weston Electrical Instrument Company, Waverly Park, Newark, N. J., distributed at the recent convention of the Interstate Independent Telephone Association a handy reference manual for engineers. This book has been compiled by Charles E. Ferris, B. S., professor of mechanical engineering at the University of Tennessee, and printed by the University Press, Knoxville, Tenn. The booklet contains a mine of information for busy men and engineers, and is one of the most useful souvenirs which has ever been distributed.

THE SMITH & HEMENWAY COMPANY, New York city, has contracted with the Page-Storms Forge Company to handle the entire marketing on its engineers' wrenches, and hereafter the Page-Storms company's New York office will be at 296 Broadway, care the Smith & Hemenway Company, which will look after this end of the business exclusively. In addition to manufacturing drop-forged engineers' wrenches, the company makes a specialty of making forgings from blue-prints or samples. Parties interested or wishing to have forgings made, will make their requests known direct to the factory at Brightwood, Mass.

MESSRS. DODGE & DAY, Nicetown, Philadelphia, Pa., are presenting their friends and patrons with a souvenir copy of the article by Mr. Charles Day, on "The Machine Shop Problem," which was read at the Saratoga meeting, June, 1903, of the American Society of Mechanical Engineers. This article is an analysis of the betterment reports issued by Messrs. Dodge & Day. These reports outline a policy that prevents erratic expenditure and ensures steady improvement in plant output. Dodge & Day not only take charge of new work, but examine and report on existing conditions, suggesting betterment which can be made systematically through a term of improvement.

THE INCANDESCENT ELECTRIC LIGHT MANIPULATOR COMPANY, Boston, Mass., has recently made an improvement in its style 3 flexible-shaft lamp replacer. The shaft is now made telescopic, and can be operated just as easily as the non-telescopic apparatus. The company reports that business in this line so far this season has been almost double that of last year. The company is now placing on the market its new "Morse" adjustable arm fixtures, which are especially adapted for mills, factories and shops, and which it claims are very simple in construction and strong and durable. Illustrated price lists will be sent upon request.

THE EDISON PORTLAND CEMENT COMPANY, Stewartsville, N. J., will be pleased to send a copy of the report made by Lathbury & Spackman, Incorporated, Philadelphia, Pa., on a test of Edison Portland cement. In fineness, 99.8 per cent passed a No. 100 sieve, and 91.6 per cent passed a No. 200 sieve. A cold water and air patent test, under the specifications of the American Society of Civil Engineers, was very good, and the setting-time record was as follows: initial set, two hours; final set, six hours and thirty minutes; percentage of water, twenty-five; temperature of air, seventy-two degrees Fahrenheit; temperature of water, seventy-three degrees Fahrenheit. An accelerated test gave a good boiling-water test, and gave a specific gravity of 3.16. In the tensile strength of standard briquettes, one square inch in section, a neat briquette, under a test of twenty-four hours in air, gave an average strength of 325 pounds. A neat briquette, twenty-four hours in the air and six days in water, gave an average strength in pounds of 676. A briquette of one part of cement and three of sand, twenty-four hours in air and six in water, gave an average of 255 pounds. A briquette one part cement and three parts sand, twenty-four hours in air and seven days in water, gave an average of 331 pounds. The chemical analysis showed 20.14 per cent silica, 7.51 per cent alumina, 3.33 iron oxide, 62.71 lime, 2.34 magnesia, 1.64 per cent sulphuric anhydride. The ratio of lime to silica was 3.11 to 1.